AIR FORCE **T.O. 31M1-2FMQ13-2**

ARMY **TM 11-6660-282-20**

TECHNICAL MANUAL

MAINTENANCE INSTRUCTION MANUAL

WIND MEASURING SET

AN/FMQ-13(V)

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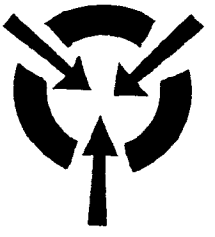
FORWARD

This manual provides the maintenance instructions for the AN/FMQ13(V) Digital Wind Measuring Set. This information is presented in five chapters. Chapter 1 starts with an introduction followed by a description of the equipment and a description of its application. The chapter ends with the leading particulars for the set. Chapter 2 has two sections. Section I covers the installation logistic. Section II contains the installation procedure including installation planning, pre-installation setup and checks and the installation sequence. Chapter 3 has two sections. Section I covers preparation for use of the equipment. Section II covers preparation for reshipment. Chapter 4 covers the theory of operation which is provided in the "Operation Instruction Manual" T.O. 31M1-2FMQ13-1. Chapter 5 has three sections. Section I covers organizational and intermediate maintenance. Section II covers special maintenance. Section III provides performance test checks.

SAFETY SUMMARY

The following are general safety precautions that are not related to any specific procedures and therefore do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance.

ELECTROSTATIC DISCHARGE SENSITIVE DEVICES. This equipment may contain electrostatic discharge sensitive (ESDS) devices. Equipment handling methods and materials must be used to prevent equipment damage. Refer to Air Force Technical Order OO-25-234, Section VII for safety precautions before performing disassembly, repair and assembly. The requirements for marking assemblies, sub-assemblies and parts are governed by MIL STD 1686A, DOD HDBK 263, MIL STD 1285A and MIL STD 129.



PAGE

2-19 **WARNING - THE SPIKES ON THE TOP OF THE SENSOR HAVE SHARP POINTS. COVER SPIKES WITH SUITABLE PROTECTIVE MATERIAL. HANDLE SENSOR ASSEMBLY WITH CARE. FAILURE TO DO SO CAN CAUSE INJURY.**

2-21 **WARNING - THE SPIKES ON THE TOP OF THE SENSOR HAVE SHARP POINTS. COVER SPIKES WITH SUITABLE PROTECTIVE MATERIAL. HANDLE SENSOR ASSEMBLY WITH CARE. FAILURE TO DO SO CAN CAUSE INJURY.**

WARNING - ENSURE THAT AC POWER HAS BEEN REMOVED FROM THE CABLE RUNNING THROUGH THE MOUNT. REMOVE AC VOLTAGE AT THE SOURCE. FAILURE TO DO SO CAN CAUSE INJURY OR DEATH.

2-29 **CAUTION** - When installing the paper access cover onto the printer chassis assembly, the grommets of the latches must be completely inserted into the latch holes of the printer chassis assembly. Be certain that the back of the access panel butts up against the flange of the printer chassis assembly before pushing the plunger in to expand the grommet. Failure to do so can cause the latch grommet to be damaged creating an ineffective latch.

5-13 **WARNING - THE SPIKES ON THE TOP OF THE SENSOR HAVE SHARP POINTS. COVER SPIKES WITH SUITABLE PROTECTIVE MATERIAL. HANDLE SENSOR ASSEMBLY WITH CARE. FAILURE TO DO SO CAN CAUSE INJURY.**

5-33 **CAUTION** - Before performing the following steps, personnel should be effectively static protected. Further disassembly should take place at a static-free work station. Failure to do so can damage equipment.

5-39 **CAUTION** - Before performing the following steps, personnel should be effectively static protected. Further disassembly should take place at a static-free work station. Failure to do so can damage equipment.

5-45 **CAUTION** - Further disassembly of the sensor should take place at a static-free work station by static protected personnel. Failure to do so can damage equipment.

SAFETY SUMMARY - CONT

PAGE

5-53 **CAUTION** - Use only isopropyl alcohol for cleaning the sensor elements. Use of other solvent may damage the elements. Failure to do so can damage equipment.

5-54 **WARNING - COMPRESSED AIR IS DANGEROUS AND CAN CAUSE SERIOUS BODILY HARM. IT CAN ALSO CAUSE MECHANICAL DAMAGE TO THE EQUIPMENT. DO NOT USE COMPRESSED AIR TO DRY PARTS WHERE CLEANING COMPOUND HAS BEEN USED.**

5-54 **WARNING - REMOVE POWER FROM THE SENSOR BEFORE ATTEMPTING TO CLEAN THE ELEMENT. FAILURE TO REMOVE POWER MAY CAUSE INJURY TO PERSONNEL AND/OR DAMAGE TO EQUIPMENT.**

5-54 **WARNING - THE SPIKES ON THE TOP OF THE SENSOR HAVE SHARP POINTS. COVER SPIKES WITH SUITABLE PROTECTIVE MATERIAL. HANDLE SENSOR ASSEMBLY WITH CARE. FAILURE TO DO SO CAN CAUSE INJURY.**

5-54 **WARNING - THE FOLLOWING CLEANING PROCEDURE INVOLVES SPRAYING ISOPROPYL ALCOHOL. USE PROTECTIVE EYE COVERING SUCH AS SAFETY GOGGLES WHEN CLEANING THE SENSOR ELEMENTS. DO NOT SPRAY ALCOHOL NEAR EXPOSED FLAME. FAILURE TO DO SO CAN CAUSE INJURY TO PERSONNEL AND/OR DAMAGE TO EQUIPMENT.**

5-54 **CAUTION** - Use only Isopropyl alcohol to clean the elements. Use of other types of cleaning fluids can damage the elements.

5-55 **CAUTION** - Use of excessive force will damage the elements. Use care when cleaning the elements.

5-62 **CAUTION** - AC power to the indicator/recorder subassembly test set must be "off" while installing battery enable jumper E1 to prevent damage to the microprocessor PCBA.

5-84 **WARNING - THE FOLLOWING VOLTAGE MEASUREMENT POINT HAS 115 VAC POTENTIAL. USE CAUTION WHILE MEASURING VOLTAGE. FAILURE TO DO SO CAN CAUSE INJURY OR DEATH.**

CHAPTER 1

GENERAL INFORMATION

1-1 INTRODUCTION

1-1.1 **Purpose and Scope of Technical Order**. This technical order contains instructions for installing and maintaining Wind Measuring Set AN/FMQ-13(V) (hereinafter referred to as wind measuring set), manufactured by The Sutron Corporation, Herndon, Virginia. The technical order is arranged as follows:

Chapter 1 - General Information. This chapter provides general information for the wind measuring set including system application, equipment description, leading particulars, equipment supplied, and related technical manuals.

Chapter 2 - Installation. This chapter provides complete installation instructions for the wind measuring set including installation logistics and installation procedure.

Chapter 3 - Preparation for Use and Reshipment. This chapter contains information which will permit maintenance personnel to perform preliminary checks before operating the equipment for the first time.

Chapter 4 - Operation and Theory of Operation. This chapter provides operating instructions for the wind measuring set adequate for the maintenance technician. Reference is made to the Operation Instruction Manual for theory of operation.

Chapter 5 - Maintenance. This chapter provides all instructions required for on-equipment and off-equipment maintenance of the wind measuring set.

1-1.2 **Purpose of System**. The wind measuring set is intended for use in military base weather stations and on flight lines worldwide to continuously measure, display, and record horizontal wind direction, wind speed, and wind gust information.

1-1.3 **System Configuration**. The wind measuring set (FIGURE 1-1) consists of the following major assemblies:

Common Name	Official Nomenclature
Wind Measuring Set	Wind Measuring Set AN/FMQ-13(V)
Sensor	Sensor, Standard, Wind Measuring ML-660/FMQ-13(V)
Sensor	Sensor, Ruggedized, Wind Measuring ML-660A/FMQ-13(V)
Indicator	Digital Display Indicator ID-2408/FMQ-13(V)
Recorder	Wind Direction and Speed Recorder RO-588/FMQ-13(V)

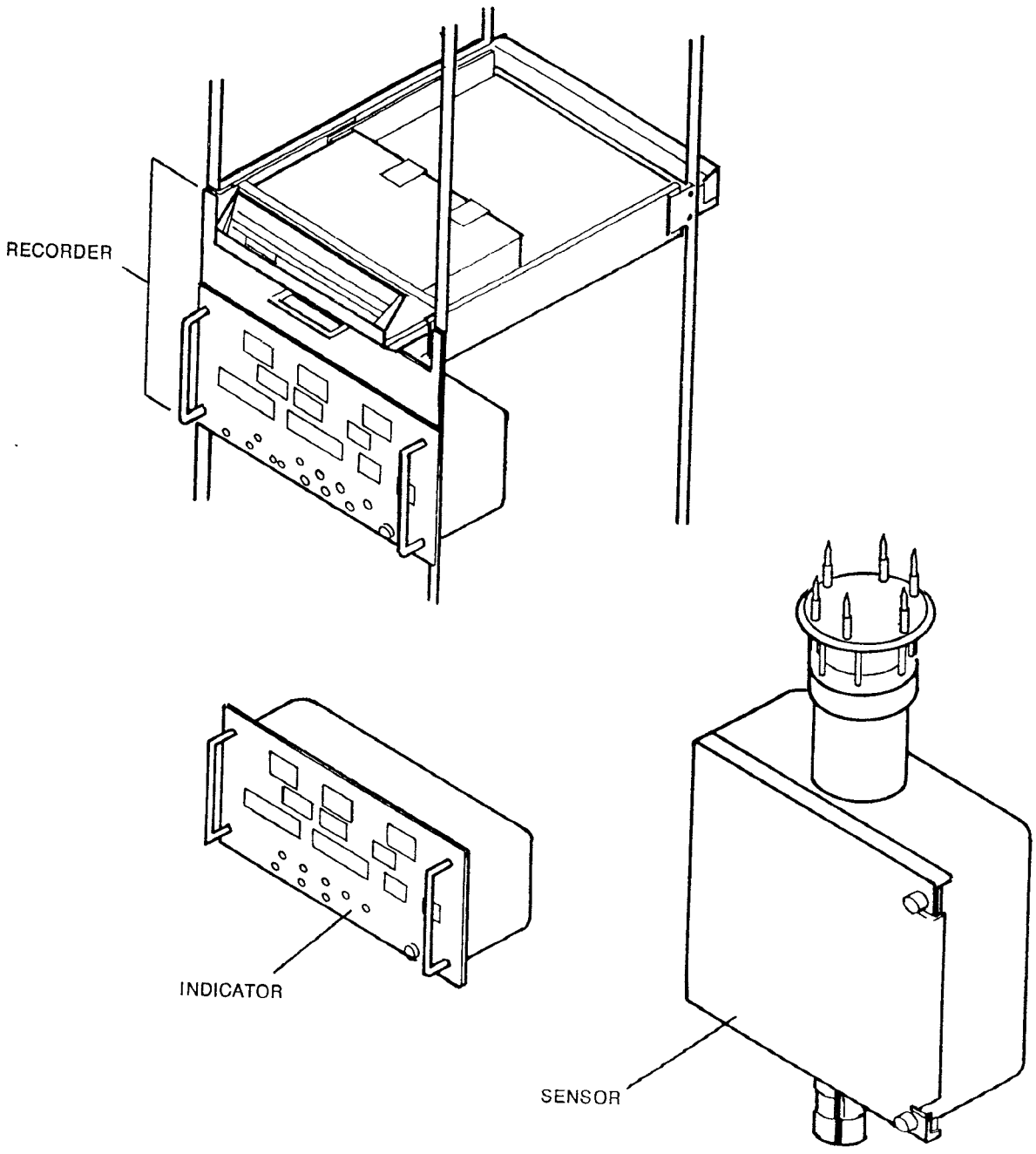


FIGURE 1-1. Wind Measuring Set AN/FMQ-13(V)

1-2 EQUIPMENT DESCRIPTION.

Refer to paragraphs 1-2.1 through 1-2.3 for a description of the equipment comprising the wind measuring set. A system can be comprised of these assemblies in various combinations as described in paragraph 1-3. A brief description of these assemblies is given in the following paragraphs.

1-2.1 **Sensor**. (See FIGURES 1-2, 1-3 and 1-4.) The wind measuring set can be configured with either a standard sensor or ruggedized sensor. Both sensors provide the capability of measuring wind direction from 0-360 degrees. In addition, the ruggedized sensor provides the capability of measuring wind speed from 0-150 knots, while the standard sensor provides the capability of measuring wind speed from 0-99 knots. Both sensors are identical except for the EPROM (Erasable Programmable Read Only Memory) which contains the temperature vs resistance data of the temperature circuit, voltage vs barometric pressure relationship of the barometric pressure circuit, gains and offsets for the D/A (digital-to-analog) and A/D (analog-to-digital) convertors, and the calibration data for the sensor. The EPROM in the ruggedized sensor is characterized by a wider range of performance characteristics.

Each sensor (FIGURE 1-2) consists of a control assembly and a power assembly. The control assembly (FIGURE 1-3) includes a protective cage which mounts two pairs (X and Y) of thick film platinum elements mounted perpendicular to each other. The X pair of elements is the East-West pair. The Y pair of elements is the North-South pair. By using two pairs of elements at right angles to each other, it is possible to calculate wind direction and speed .

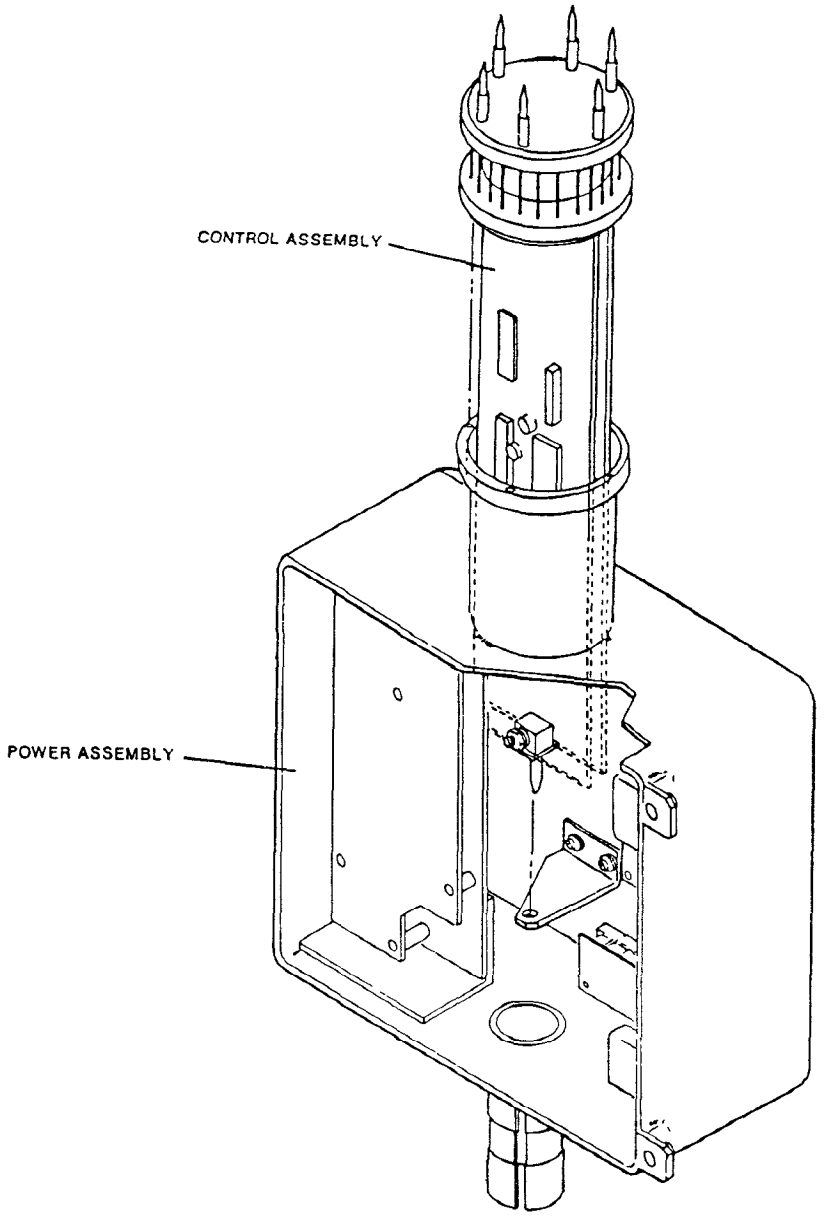


FIGURE 1-2. Wind Speed and Direction Sensor

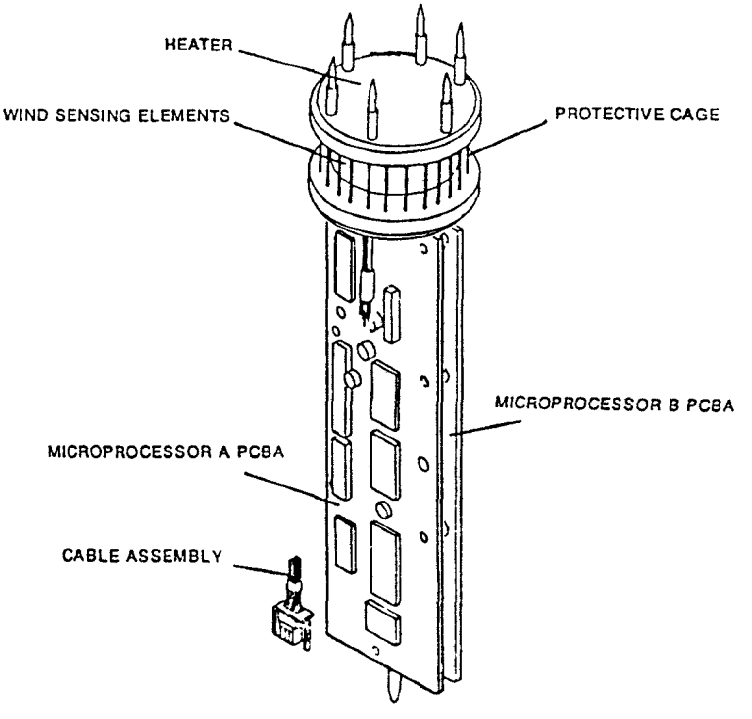


FIGURE 1-3. Wind Speed and Direction Sensor, Control Assembly

A protective cage safeguards the sensing elements. The cage contains a heater which keeps ice from forming on the cage and obstructing the flow of air across the elements.

The elements are maintained at a temperature approximately 100 degrees C above ambient. As the wind blows across the elements, heat is removed and more power is required to maintain the elevated temperature. The power required to maintain a constant temperature is measured by the sensor electronics and the wind velocity is calculated from these measurements.

When the control assembly is mounted to the power assembly, the two microprocessor printed circuit board assemblies (PCBAs) will be fitted through the sensor support (FIGURE 1-4) into the power assembly watertight enclosure where they are firmly sealed to prevent shock and vibration.

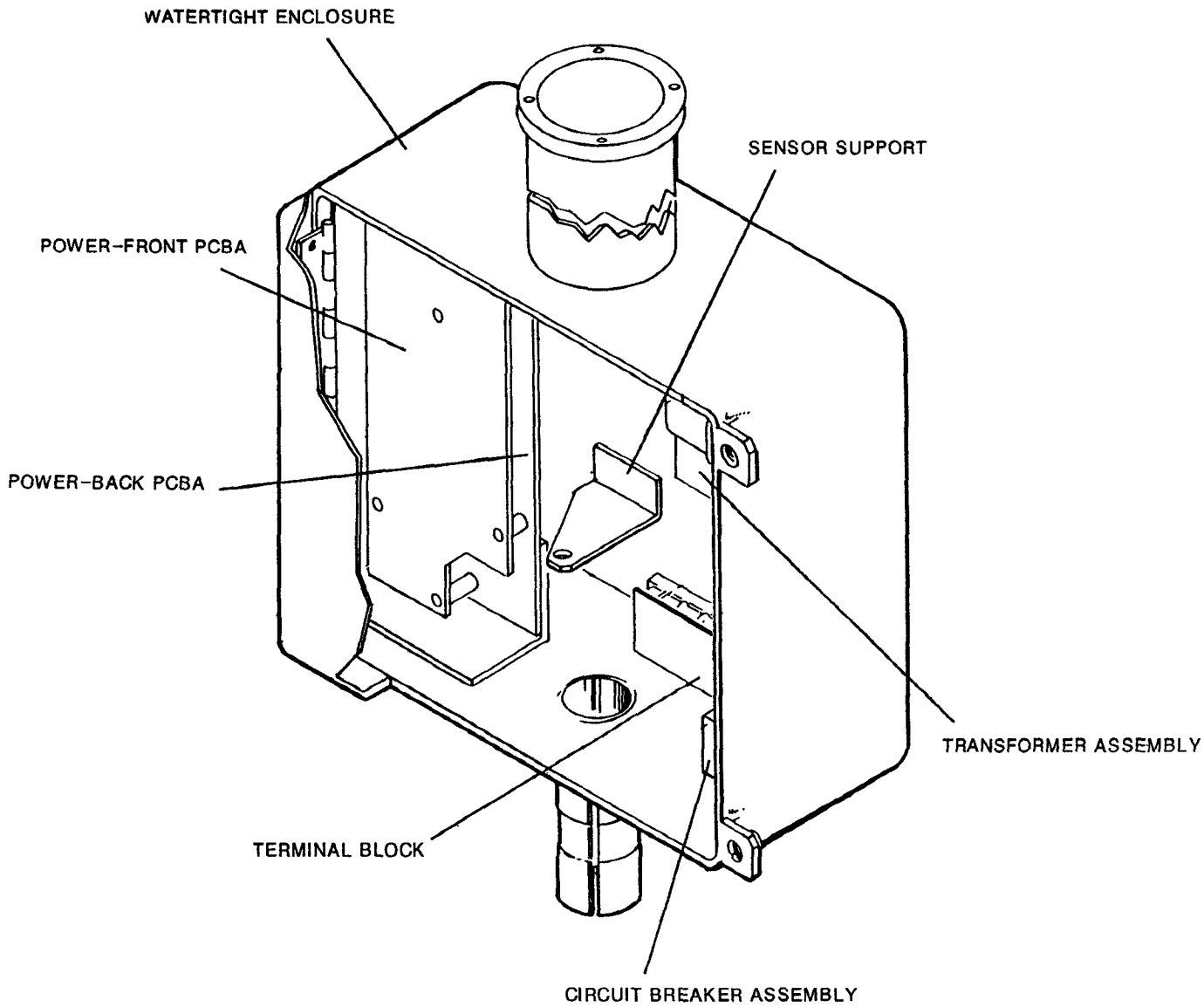


FIGURE 1-4. Wind Speed and Direction Sensor, Power Assembly

The power assembly (FIGURE 1-4) includes a watertight enclosure which houses two PCBAs (power-front and power-back) which contain the sensor power supply and communication circuit, a circuit breaker assembly, a transformer assembly, and a terminal block with cover. The sensor is mounted onto a 1-inch pipe using a U bolt for compression. Electrical connections to the sensor are made to a terminal block in the power assembly watertight enclosure.

1-2.2 **Indicator**. (See FIGURES 1-5 and 1-6.) The wind measuring set uses two versions of the indicator (dash 1 and dash 2). The dash 1 version is a standalone indicator. The dash 2 version forms part of the recorder and is identical to the dash 1 indicator except for the addition of two connectors (AC POWER OUT and PRINTER) on the rear panel and minor changes to the display printed circuit board assembly (PCBA), interconnection PCBA, and front panel designations.

Each indicator is comprised of a top cover assembly (with EMI gasket), display panel, two handles, circuit breaker assembly, display intensity adjust potentiometer, EMC window, communications cable assembly, configuration switch assembly, AC output cable assembly (dash 2 only), pushbuttons/ lamps, 7-segment displays, interconnection PCBA, microprocessor PCBA, display PCBA, and a display chassis which mounts a power transformer and two voltage regulators. The 7-segment displays, pushbuttons, and lamps visible through the display panel are part of the display PCBA. Their function, as well as the function of all operator controls, displays, lamps, and connectors, is described in Chapter 2 of the Operation Instruction Manual, T.O. 31M1-2FMQ13-1. All switches, displays, lamps, voltage regulators, power transformer, and other components mounted on the front and rear panels and display chassis are interfaced to the indicator electronics and power supply circuits via the interconnection PCBA.

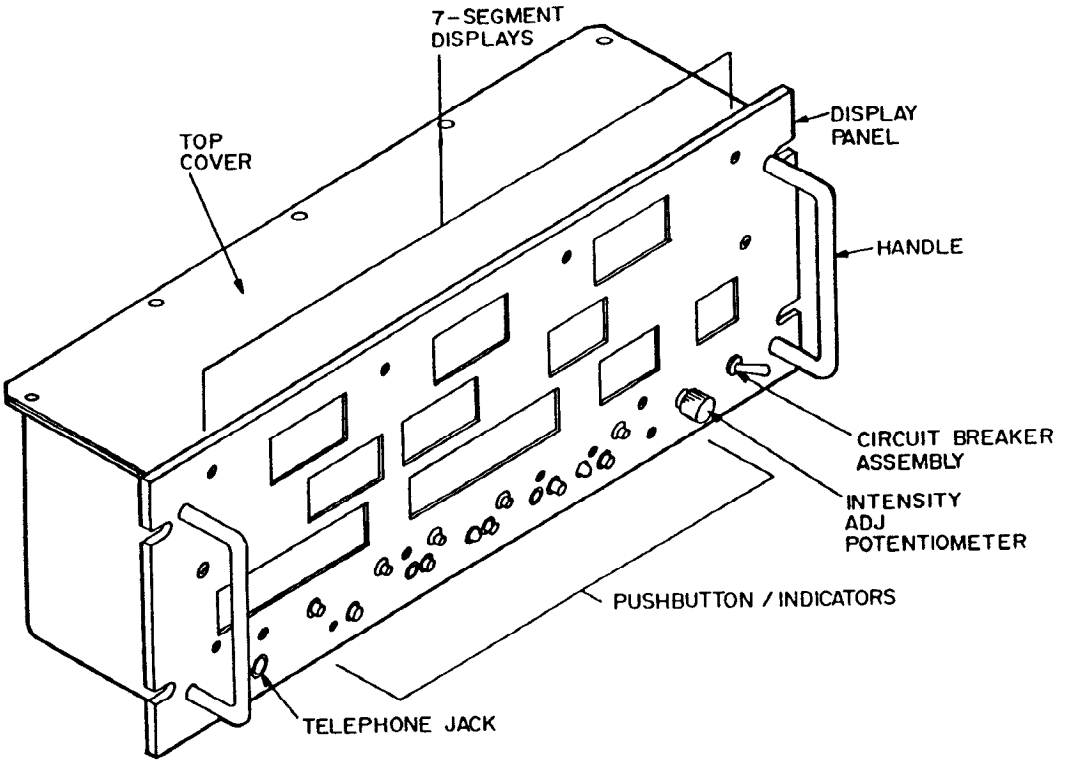


FIGURE 1-5. Digital Display Indicator ID-2408/FMQ-13(V), Front View

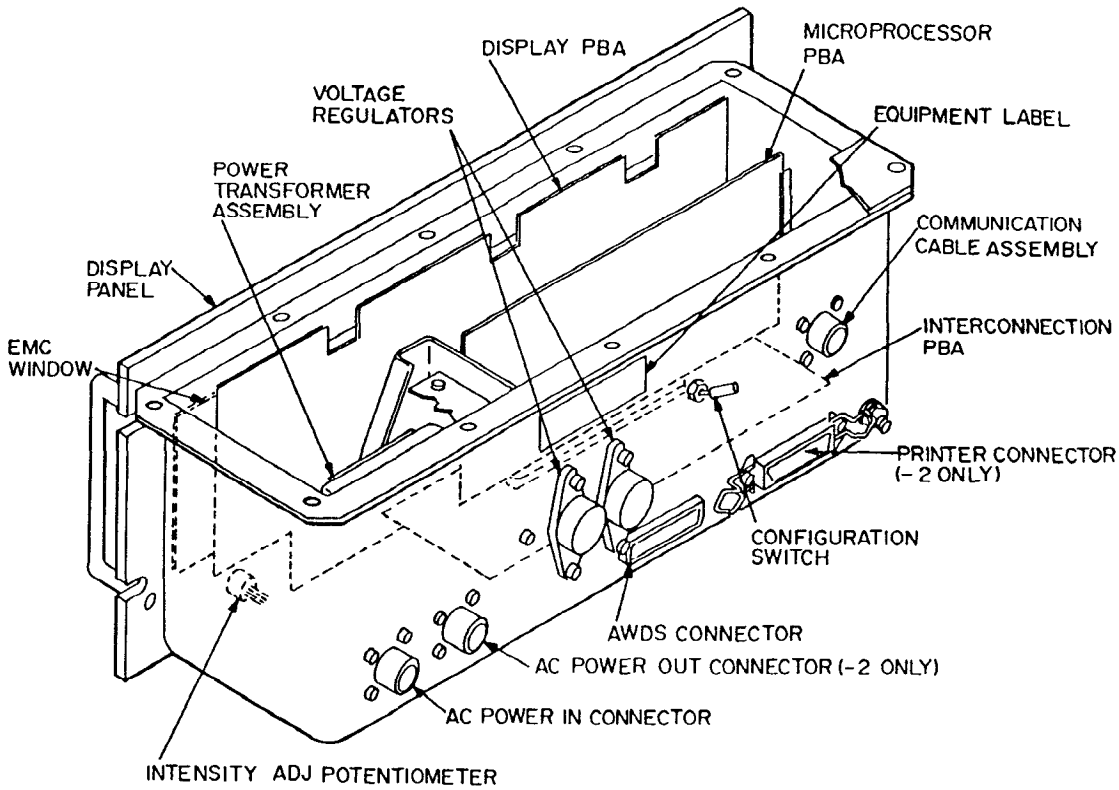


FIGURE 1-6. Digital Display Indicator ID-2408/FMQ-13(V), Rear View

The indicator (both dash 1 and dash 2 versions) provides readouts of wind information (wind direction, wind speed, direction variability, gusts, gust spread) processed from 5-second averages received from all sensors. The processed weather information is displayed on 7-segment displays on the indicator front panel along with the time and date, active sensor identification, and fault status. The indicator is designed for mounting either in a standard 19-inch rack or in a CY-2732/FMQ-13(V) Indication Case

1-2.3 **Recorder**. (See FIGURES 1-7 and 1-8.) The recorder (FIGURE 1-7) is comprised of an indicator (dash 2 version), printer with slide mounting shelf, paper tray, paper access cover, AC power cable assembly, printer power cable assembly, and printer interface cable assembly. The printer shelf is equipped with captive hardware for slide mounting in a standard 19-inch equipment rack. Once each minute, the printer provides a hard copy printout of all weather parameters displayed on the 7-segment displays plus time/date information, peak wind values, standard deviation, and status. All information for each minute's recording will be printed out on the same line. The order of presentation of the data will be as follows: date-time group; wind direction (DIR); wind speed (SPD); gusts (GST); direction variability (DIR-VAR); gust spread (GSP); 10-minute peak-wind direction, speed, and time of occurrence; latest hour peak-wind direction, speed, and time occurrence; latest 24-hour peak-wind direction, speed, and time of occurrence; standard deviation; status; and active sensor identification. Header information is provided on the printout to clearly identify all recorded information. All time is based on a 24-hour clock and is displayed to the latest minute. Wind data to be recorded will be from the sensor specified as the active sensor on the master indicator. FIGURE 1-8 is a typical printout of weather information.

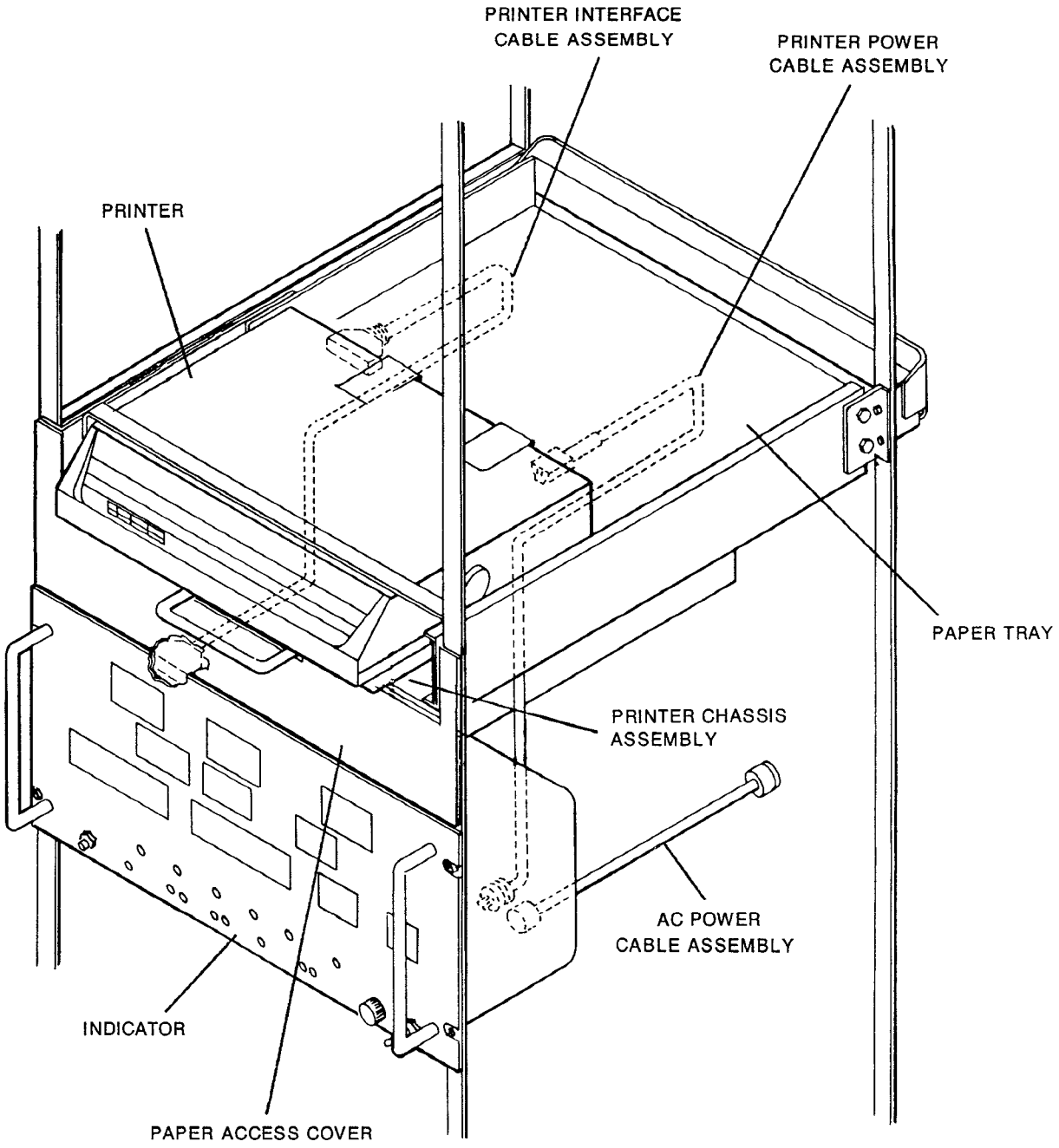


FIGURE 1-7. Wind Direction and Speed Recorder RO-588/FMQ-13(V)

								10 MIN. PEAK			60 MIN. PEAK			24 HOUR PEAK					
DATE	TIME	DIR	SPD	GST	DIR - VAR		GSP	DIR	SPD	TIME	DIR	SPD	TIME	DIR	SPD	TIME	SD	AS	ST
01/07/89	15:44	344	001	000	084	359	001	112	003	15:34	136	005	14:09	343	011	03:08	060	01	00
01/07/89	15:45	306	002	000	084	359	002	280	005	15:44	136	005	14:09	343	011	03:08	060	01	00
01/07/89	15:46	290	004	000	084	359	001	282	005	15:45	136	005	14:09	343	011	03:08	055	01	00
01/07/89	15:47	291	005	000	091	359	001	291	005	15:46	136	005	14:09	343	011	03:08	050	01	00
01/07/89	15:48	295	005	000	179	359	001	291	005	15:46	136	005	14:09	343	011	03:08	044	01	00
01/07/89	15:49	296	005	000	184	359	001	296	005	15:48	136	005	14:09	343	011	03:08	032	01	00
01/07/89	15:50	290	005	000	259	359	001	296	005	15:48	136	005	14:09	343	011	03:08	024	01	00
01/07/89	15:51	283	005	000	259	359	001	286	006	15:50	136	005	14:09	343	011	03:08	018	01	00
01/07/89	15:52	275	005	000	256	359	001	279	006	15:51	136	005	14:09	343	011	03:08	018	01	00
01/07/89	15:53	274	004	000	256	355	001	279	006	15:51	136	005	14:09	343	011	03:08	018	01	00
01/07/89	15:54	274	003	000	256	305	002	279	006	15:51	136	005	14:09	343	011	03:08	014	01	00
01/07/89	15:55	276	004	000	256	304	001	279	006	15:51	279	006	15:51	343	011	03:08	010	01	00
01/07/89	15:56	275	004	000	254	304	002	279	006	15:51	279	006	15:51	343	011	03:08	010	01	00
01/07/89	15:57	268	003	000	251	304	002	279	006	15:51	279	006	15:51	343	011	03:08	011	01	00
01/07/89	15:58	267	003	000	251	302	002	279	006	15:51	279	006	15:51	343	011	03:08	012	01	00
01/07/89	15:59	267	003	000	251	302	002	279	006	15:51	279	006	15:51	343	011	03:08	011	01	00
01/07/89	16:00	263	003	000	242	291	002	279	006	15:51	279	006	15:51	343	011	03:08	010	01	00
01/07/89	16:01	266	003	000	242	289	001	279	006	15:51	279	006	15:51	343	011	03:08	010	01	00
01/07/89	16:02	276	003	000	242	297	001	282	005	15:54	279	006	15:51	343	011	03:08	009	01	00
01/07/89	16:03	281	003	000	242	297	001	282	005	15:54	279	006	15:51	343	011	03:08	010	01	00
01/07/89	16:04	289	003	000	242	303	001	282	005	15:54	279	006	15:51	343	011	03:08	010	01	00
01/07/89	16:05	288	003	000	242	303	001	271	004	15:55	279	006	15:51	343	011	03:08	012	01	00
01/07/89	16:06	285	003	000	242	303	000	264	004	15:56	279	006	15:51	343	011	03:08	012	01	00
01/07/89	16:07	287	003	000	242	305	001	262	004	15:57	279	006	15:51	343	011	03:08	012	01	00
01/07/89	16:08	297	003	000	242	318	001	287	004	16:04	279	006	15:51	343	011	03:08	012	01	00
01/07/89	16:09	314	003	000	242	341	001	287	004	16:04	279	006	15:51	343	011	03:08	011	01	00
01/07/89	16:10	318	003	000	265	341	002	287	004	16:04	279	006	15:51	343	011	03:08	011	01	00
01/07/89	16:11	304	003	000	265	341	001	287	004	16:04	279	006	15:51	343	011	03:08	009	01	00
01/07/89	16:12	306	003	000	273	341	002	316	004	16:11	279	006	15:51	343	011	03:08	009	01	00
01/07/89	16:13	305	003	000	273	341	001	316	004	16:11	279	006	15:51	343	011	03:08	009	01	00

FIGURE 1-8. Typical Printout of Weather Information

The printer provides the ASCII 96 character set with upper and lower case characters and true descenders, double width, and enhanced print characters. The printer is provided with a re-inking ribbon cartridge which delivers crisp quality up to 3 million characters.

A plate at the top rear of the printer provides access to DIP switches which allow selection of printer function. These switches control selection of language characters, the form length setting, line feed options, and must be set to match the protocol used by the microprocessor PCBA in the indicator.

The recorder is equipped with an audible alarm to alert base weather station personnel when the operator in the control tower selects a different active sensor. The alarm has a manual reset switch on the front panel of the recorder to allow the operator to turn it off.

1-3 SYSTEM APPLICATION. (SEE FIGURE 1-9).

The wind measuring set is comprised of three basic major assemblies: sensor, indicator, and recorder. A minimum system consists of one sensor and one indicator or recorder. A maximum system consists of up to four sensors and a total of up to sixteen indicators and/or recorders. The sensors are mounted on masts at the end of up to four runways on the base. The indicators and recorders are located in the air traffic control tower and other buildings on the base.

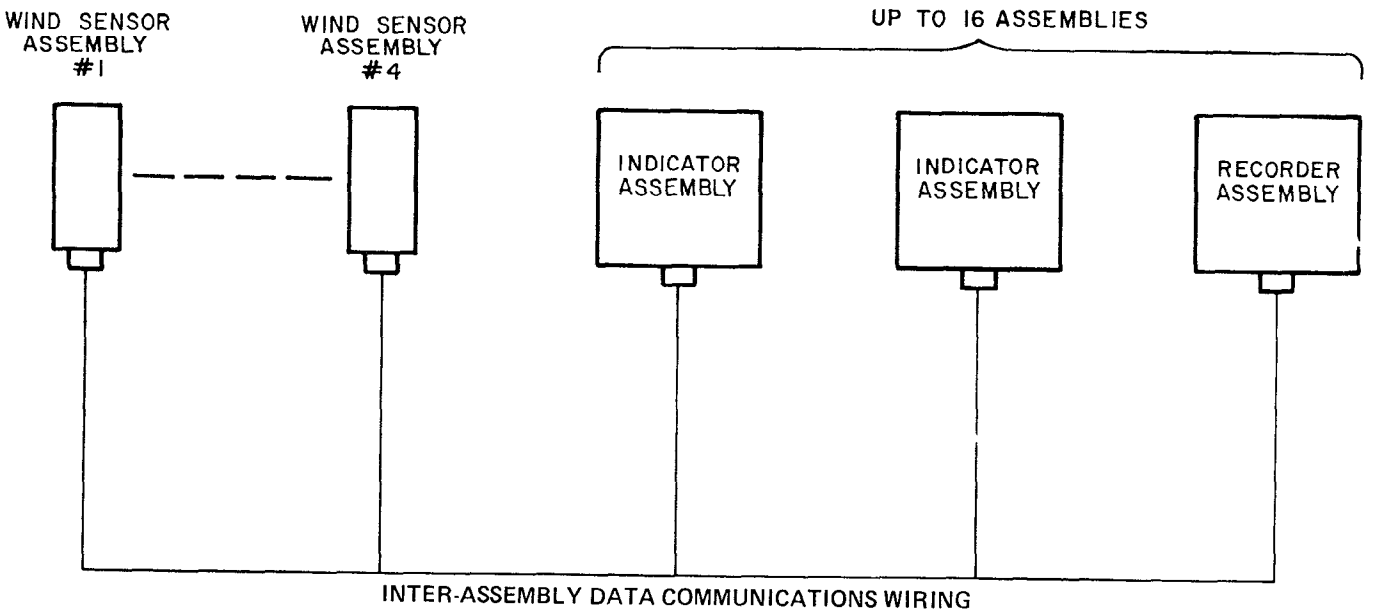


FIGURE 1-9. Wind Measuring Set, Overall Block Diagram

Both sensors (ruggedized and standard) provide the capability of measuring wind direction from 0-360 degrees. The standard sensor provides the capability of measuring wind speed from 0-99 knots, and the ruggedized sensor provides the capability of measuring wind speed from 0-150 knots. Wind samples taken over a 5-second averaged values are used by the indicators and vectorially averaged to create one direction and one speed value. These 5-second averaged values are used by the indicators and recorders to calculate and display/record further wind information. One, and only one, of the possible sixteen indicators and/or recorders in the system is designated as the 'master' by means of a switch on the rear panel of that unit.

The master indicator/recorder polls all sensors every 5 seconds. When polled, wind velocity information from all sensors is simultaneously transmitted to all indicators and recorders in the system over the inter-assembly data communications channel. Data from the active sensor is displayed on all indicators unless the operator momentarily selects display of wind information from another sensor. The inter-assembly data communications channel usually consists of a single dedicated pair of wires, less than 20,000 feet long, running between all assemblies on a single air base; however, a 3002-type two-wire private line data channel may be used in addition to, or in place of, the dedicated wires to accommodate much longer distances between assemblies.

The inter-assembly data communications channel allows the four sensors and up to sixteen indicators/ recorders to be tapped into a single pair of wires. Thus, the wind direction and wind speed information from each addressed sensor is fed simultaneously , to all indicators and recorders in the system.

Each indicator and recorder vectorially averages 5-second wind direction from up to four sensors to provide numerical readouts (degrees or knots) for wind direction and speed, direction variability, gusts, and gust spread. This information is displayed on 7-segment displays of both the indicators and recorders. In addition, the recorder provides a hard-copy printout of all weather parameters, including all parameters displayed on the 7-segment displays plus time/date information and additional weather data for the active sensor only.

Prior to updating each numerical readout on the indicator and recorder, the system BIT (built-in test) determines if there are any faults that would affect display accuracy. When a fault is detected, the last correct readings will remain unchanged and the wind data and status displays on the indicator or recorder having the fault will flash at a rate of 1.0 +/- 0.25 Hz. The flashing STATUS display will display a general status code. Pressing the STATUS CLEAR pushbutton will cause the STATUS display to stop flashing. However, the general error code will still be displayed if the fault remains. The operator can then select the status display mode by depressing the STATUS CLEAR pushbutton while holding the LAMP TEST pushbutton depressed. This causes all displays to be blanked except the six that display a specific error code. With the status display mode selected, the TIME display flashes all zeros to alert the operator that the indicator/recorder is not in its normal operating mode.

Each indicator and recorder provides the capability of communicating with an automated observing system (AOS) via the Automated Weather Distribution System (AWDS) interface. At the end of each 5-second update of the active sensor, the following data for each sensor is available for transmission from each indicator and recorder: message header date-time group; wind direction; wind speed; gusts; direction variability; gust speed; 10-minute peak-wind direction, speed, and time of occurrence; latest 24-hour peak-wind direction, speed, and time of occurrence; standard deviation; and active sensor identification and status code.

FIGURE 1-10 provides an example of the AWDS message and shows the location of each data field. Table 1-1 provides a description of each field, the range of values that the field can contain, the length of each field, and the field start position for each field.

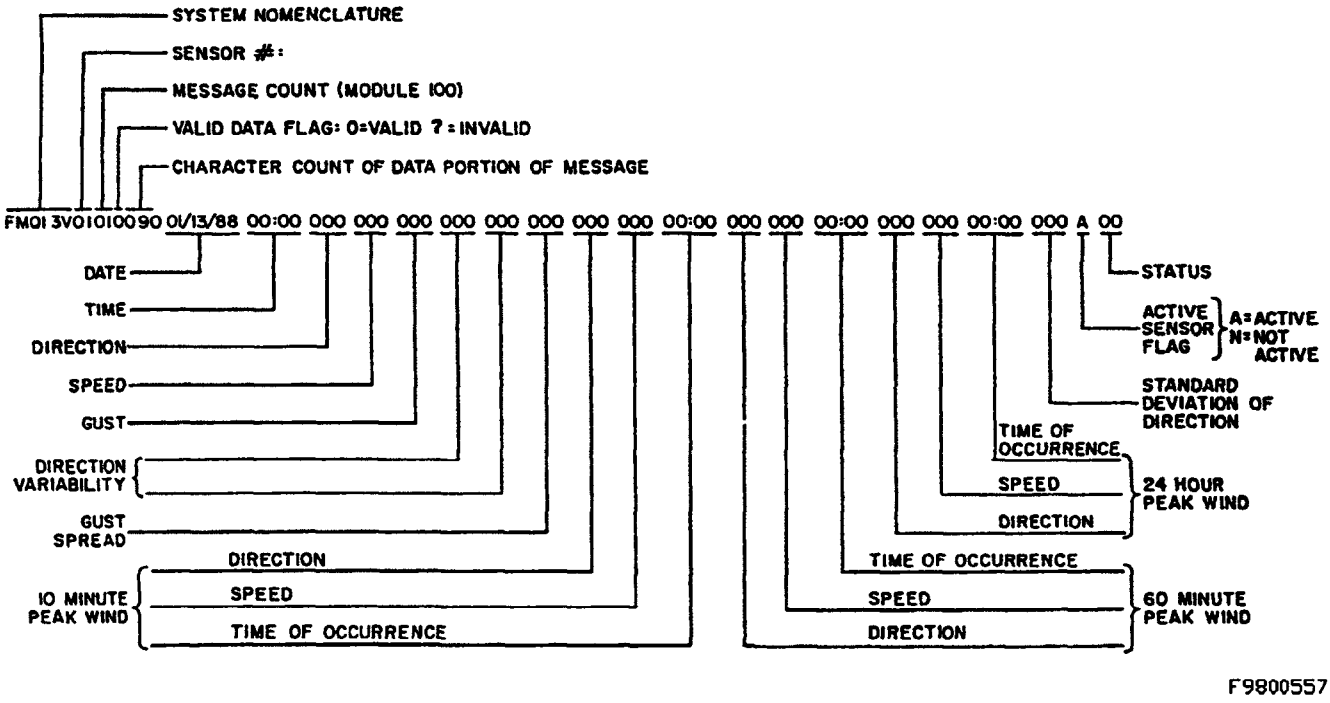


Figure 1-10. AWDS Message

Table 1-1. AWDS Output Format

FIELD NAME	CONTENT	FIELD LENGTH	FIELD POSITION
System Nomenclature	FMQ13(V)	6	1
Sensor #	01-04	2	7
Message Count (Modulo 100)	00-99	2	9
Valid Data Flag	? or 0	1	11
Character Count	090	34	12
Meteorological Data:			
Date	MM/DD/YR	8*	16
Time	HH:MM	5*	25
Wind Direction	000-360	3*	31
Wind Speed	000-250	3*	35
Gust	000-250	3*	39
Direction Variability 1	000-360	3*	43
Direction Variability 2	000-360	3*	47
Gust Spread	00-99	3*	51
10-Minute Peak Wind Direction	000-360	3*	55
10-Minute Peak Wind Speed	000-250	3*	59
10-Minute Peak Time	HH:MM	5*	63
60-Minute Peak Wind Direction	000-360	3*	69
60-Minute Peak Wind Speed	000-250	3*	73
60-Minute Peak Time	HH:MM	5*	77
24-Hour Peak Wind Direction	000-360	3*	83
24-Hour Peak Wind Speed	000-250	34	87

Table 1-1. AWDS Output Format - CONT

FIELD NAME	CONTENT	FIELD LENGTH	FIELD POSITION
24-Hour Peak Time	HH:MM	5*	91
Standard Deviation of Direction	000-180	3*	97
Active Flag	N or A	1*	101
Status	00-77	2	103
Message Termination	CRLF	2	105

1-4 LEADING PARTICULARS.

The leading particulars of the wind measuring set are given in the following paragraphs:

1-4.1 Performance Characteristics.

1-4.1.1 System.

Operating Range:

Wind Speed ..... 0-150 knots (ruggedized sensor); 0-99 knots (standard sensor)

Wind Direction..... 0-360 degrees

Accuracy:

Speed..... 0-50 knots +/- 1 knot
50-75 knots +/- 5%
75-99 knots +/- 10%
99-150 knots +/- 15% (ruggedized only).

Direction ..... +/- 3 degrees

Sensitivity:

Constant Wind Speed ..... As little as 1 knot

Shift in Wind Direction..... As little as 3 degrees shift in wind direction at a wind speed of 1 knot

Primary Power ..... 115/230 VAC +/- 10%, 47-63 Hz, single phase (all assemblies).
Requirement 115/230 VAC is selectable by internal strapping

1-4.1.2 **Sensor Assembly**.

Sensor Response Time:

Wind Speed..... Time required for sensors to respond to 63 percent of a 25 knot step change in wind speed in no less than 1 second and no more than 5 seconds.

Wind Direction..... Time required for sensors to respond to 63 percent of a 90 degree instantaneous shift in wind direction at a constant speed of 25 knots in no less than 1 second and no more than 5 seconds.

Sensor Processing ..... The wind velocity is sampled at least once per second; 5-second samples are grouped and vectorially averaged to create one wind direction and one wind speed value. The 5-second averaged values are then used by the indicator and recorder to calculate further wind information.

Built-In Self-Test..... Ensures that the sensor assemblies are performing (BIT) as required. Fault indications are displayed on the front panel of both indicator and recorder assemblies.

1-4.1.3 **Indicator Assembly**.

Range of Wind Speed..... Greater than 150 knots.

Displays

Visual Display:

Readability..... All visual displays have a viewing angle of +/- 60% from the perpendicular in both horizontal and vertical axes.

Wind Direction..... Wind direction displayed to the nearest degree. Display updated every 5 seconds.

Wind Speed..... Wind speed displayed to the nearest knot. Display updated every 5 seconds.

Gusts..... Maximum wind gusts within the last 10 minutes displayed to the nearest knot. Display updated every 5 seconds.

Wind Direction Variability..... Displayed by presenting two values ("XXX" and "YYY") which bracket in a clockwise direction the wind direction observed within the past 10 minutes. Display updated every 5 seconds. When direction variability exceeds 359 degrees the current wind direction value is displayed in both Direction Variability displays as well as the Wind Direction display.

Gust Spread..... Maximum gust spread within the past 1 minute displayed to the nearest knot. Display updated every 5 seconds.

Time	Displays real time in hours, minutes, and seconds.
Date	Displays date in day, month, and year.
Status	Flashes and displays an error code if the built-in test has detected a failure. Indicates a malfunction in the sensor, indicator, or a communications failure.
Active Sensor Identification	Active wind sensor display changed on all indicators when a different a different sensor is selected via the sensor selector switch on the master assembly.
Inter-Assembly Communications	Indicator provided with a MIL-J-641, type JJ-134 telephone jack for communication by maintenance personnel among sensor, indicator, and indicator locations.
Momentary Wind Sampling Capability	Each indicator has the capability of over-riding the active sensor selector switch and momentarily displaying data from any of the other installed sensors. This momentary override capability automatically expires after 1 minute if not disabled sooner by the operator, and processed data from the active sensor selected by the active sensor selector switch is again displayed.
Wind Data Processing	Each indicator and recorder processes the following information from the 5-second vectorially averaged wind velocity values calculated by each sensor.
Wind Speed and Direction	Wind speed and direction readings are vectorially averaged over a 2-minute period. Computed directions of 0 and 360 degrees are displayed as 360 degrees. Calm winds are displayed as 000 direction and 000 speed. Update of these 2-minute average values is made every 5 seconds.
Gusts	Values for maximum gusts (to the nearest knot) measured within the past 10 minutes are calculated. When a gust spread of at least 10 knots has occurred and the 10-minute peak exceeds the current 2-minute average by 5 knots or more, the 10-minute wind peak will be displayed as the gust. Gusts are updated every 5 seconds. When no gusts are present, or the 2-minute wind is calm, the indicator will display zeros.
Direction Variability	Extreme values of wind direction which bracket all wind directions identified during the most recent 10-minutes of system operation are identified in a clockwise direction. When direction variability exceeds 359 degrees the current wind direction value is displayed in both Direction Variability displays as well as the Wind Direction display.
Gust Spread	Maximum gust spread over the past minute is calculated. Gust spread is defined as the maximum difference between a 5-second wind speed peak and a 5-second wind speed lull. Gust spread is updated every 5 seconds.

Peak Wind..... Peak-wind value (in knots) over the most recent 10-minute, 60-minute, and 24-hour periods. Peak wind is defined as the highest 5-second average wind speed measured by the sensor along with the associated direction and time of occurrence. The 10-minute peak-wind speed is updated every 5 seconds. The latest hourly peak wind is updated at 55 minutes after the hour and the latest 24-hour peak-wind speed at 55 minutes after the hour.

Standard Deviation of Wind Direction..... The standard deviation of wind direction (to the nearest degree) over the most recent 10-minute period is calculated. This value is updated once a minute.

Automated Weather Distribution System..... Each indicator provides the capability of communicating with an automated observing system (AWDS) Interface via the AWDS interface. At the end of each 5-second update for each sensor, the following data is available for transmission from each indicator: date-time group; wind direction; wind speed;gusts; direction variability; gust spread; 10-minute peak-wind direction, speed, and time of occurrence; latest hourly peak-wind direction, speed, and time of occurrence; latest 24-hour peak-wind direction, speed and time of occurrence; standard deviation and active sensor identification and status code. The interface follows the unbalanced generator-receiver configuration of MIL-STD-188-114. However, the capability is provided for wiring the optional grounding and balancing arrangements in MIL-STD-188-114 and for installing the voltage protection.

Built-In Self Test (BIT)..... Prior to updating each numerical readout, the indicator tests itself for faults that would affect wind data accuracy. When a fault is detected, the last correct reading will remain unchanged and the fault displays(s) will flash at a 1.0 +/- 0.25 Hz rate and an error code will be displayed.

1-4.1.4 **Recorder Assembly**.

Visual Displays

Readability..... All visual displays have a viewing angle of +/- 60° from the perpendicular in both horizontal and vertical axes.

Data Displayed..... Wind direction, wind speed, gusts, direction variability, and gust spread identical to the indicator displays. The date-time group and active sensor identification are also displayed. In addition, the 10-minute, 60-minute, and 24-hour peak-wind values and the standard deviation of wind direction can be displayed by use of the DISPLAY SELECT switches.

Time ..... Displays real time in hours, minutes, and seconds.

Date..... Displays date in day, month, and year.

Status	Flashes and displays an error code if the built-in test has detected a failure. Indicates a malfunction in the sensor, recorder, or a communications failure.
Printout	Once each minute, the recorder will printout out all parameters displayed visually on the recorder, calculated peak-wind values, standard deviation, and the date-time group of the recording. All time is based on a 24 hour clock. Wind data to be recorded is calculated from the 5-second averages from the sensor active specified by the active sensor selector switch.
Audible Alarm	Alerts base weather station personnel when the operator in the control tower selects a different sensor as the active sensor.
Inter-Assembly Communications	Recorder Provided with a MIL-J-641, type JJ-134 telephone jack for communication by maintenance personnel among sensor, indicator, and recorder locations.
Wind Data Processing	The recorder processes the following information from the 5-second vectorially averaged wind velocity values calculated by each sensor.
Wind Speed and Direction	Wind speed and wind direction readings vectorially averaged over a 2-minute period (optional 10-minute period). Computed directions of 0 degrees and 360 degrees are presented as 360 degrees. Calm winds are recorded as 000 direction and 000 speed. Update of these 2-minute average values made every 5 seconds. Displays are only updated once a minute even though the values are processed every 5 seconds.
Gusts	Values for maximum gusts (to the nearest knot) measured within the past 10 minutes are calculated. How gusts are calculated depends on whether the system is set up for 2- or 10-minute averaging. For systems set up for 2-minute averaging, the 10-minute peak wind will be displayed as the gust only when a gust spread of at least 10 knots has occurred and the 10-minute peak winds exceeds the current 2-minute average by 5 knots or more. For systems set up for 10-minute averaging, the gust is defined as the 10-minute peak wind only when the 10-minute peak wind exceeds the current 10-minute average by 5 knots or more. In each case, gusts are updated every 5 seconds. When no gusts are present, or the 2- (or 10-) minute wind is calm, the recorder will display and record all zeros.
Gust Spread	Maximum gust spread over the past minute is calculated. Gust spread is defined as the maximum difference between a 5-second wind speed peak and a 5-second wind speed lull. Gust spread is calculated every 5 seconds.
Peak Wind	Peak-wind value (in knots) over the most recent 10-minute, 60-minute, and 24-hour periods. Peak -wind is defined as the highest 5-second averaged wind speed measured by the sensor along with its associated direction and time of occurrence. The 10-minute peak wind spread is updated every 5 seconds. The latest hourly peak-wind speed is updated at 55 minutes after the hour and the latest 24-hour peak wind speed at 55 minutes after the hour.

Direction Variability..... Extreme values of wind direction which bracket all wind directions identified during the most recent 10 minutes of system operation are identified in a clockwise direction. When direction variability exceeds 359 degrees the current wind direction value is displayed in both Direction Variability displays as well as the Wind Direction display.

Standard Deviation of Wind Direction..... The standard direction of wind direction (to the nearest degree) over the most recent 10-minute period is calculated. This value is updated once a minute.

Automated Weather ..... Each recorder provides the capability of communicating with an System Distribution Automated Observing System (AOS) (AWDS) Interface via the AWDS interface. At the end of each 5-second update for each sensor, the following data is available for transmission from each recorder: date-time group; wind direction; wind spread; gusts; direction variability; gust spread; 10-minute peak-wind direction, speed, and time of occurrence; latest 24-hour peak-wind direction, speed, and time of occurrence standard deviation; and active sensor identification and status code. The interface follows the unbalanced generator receiver configuration of MIL-STD-188-114. However, the capability is provided for wiring the optional grounding and balancing arrangements in MIL-STD-188-114 and for installing voltage protection.

Built-In Self-Test (BIT)..... Prior to updating each numerical readout, the recorder tests itself for faults that would affect transmit accuracy. When a fault is detected, the last correct reading will remain unchanged and the fault display(s) will flash at a 1.0 +/- 0.25 Hz rate.

1-4.1.5 **Printer**.

Print Speed

Utility Mode	120 cps
Print Technique	Bidirectional/short line seeking Dot matrix impact
Interface	Parallel, Centronics compatible
Character Matrix (HxV).....	9x9 in Utility Mode
Characters per line	137 characters @ 17.1 cpi

Media

Number of sheets.....	1 to 4 sheets

Maximum width of paper:

Friction Feed	8.5"
Tractor feed.....	9.5"

Pin Feed ..... 10"

Paper path ..... Rear/bottom

Ribbon ..... Genuine Okidata cartridge - re-inking

Power

Voltage ..... 120, 220 or 240 VAC +/- 10%

Frequency ..... 47-63 Hz

Power (operating) ..... 35 watts

Format Controls

Vertical tabs

Top of Form Set

Horizontal Tabs

Skip Over Perforation

1-4.2 **Environmental Requirements**.

1-4.2.1 **Sensor Assemblies**.

Temperature:

Operating .....-51 to +68 degrees C

Non-operating .....-57 to +68 degrees C

Altitude:

Operating .....-100 to 15,000 feet

Non-operating .....-100 to 40,000 feet

Humidity:

Operating .....0 to 95%

Non-operating .....0 to 100 percent

Wind (Standard)	No deterioration of performance with peak winds of 99 knots or gusts of 90 knots with +/- 30 degree shift in wind direction within 10 seconds.
Wind (Ruggedized)	No damage when subjected to peak winds of 99 knots or gusts of 150 knots with +/- 60 degree shifts in wind direction within 10 seconds.
Ice, Sleet, and Snow (Standard)	No deterioration of performance 90 knots wind with an inch of radial ice buildup on the mast.
Ice, Sleet, and Snow (Ruggedized)	No deterioration of performance with 105 knot wind with an inch of radial ice buildup on the mast.

1-4.2.2. INDICATOR/RECORDER ASSEMBLIES

Temperature:

Operating	0 to +49 degrees C
Non-operating	-57 to +68 degrees C

Altitude:

Operating	-100 to 15,000 feet
Non-operating	-100 to 40,000 feet
Humidity	0 to 100 percent

1-4.3. EQUIPMENT AND ACCESSORIES SUPPLIED. Table 1-2 lists equipment and accessories supplied as part of the wind measuring set, and gives applicable weight and dimensions.

Table 1-2. Wind Measuring Set Equipment and Accessories Supplied

Qty.	Item	Dimensions			
		Width	Height	Depth	Weight
1-4	Wind Direction and Speed Sensor ML-660/FMQ-13(V)	10.69	24.75	5.125	17
1-4	Ruggedized Wind Direction and Speed Sensor ML-660A/FMQ-13(V)	10.69	24.75	5.125	17
1-16	Digital Display Indicator ID-2408/FMQ-13(V)	19.0	6.97	6.5	11
1-16	Wind Direction and Speed Recorder RO-588/FMQ-13(V)	19.0	15.72	21.8	27

1-4.4. SPECIAL TOOLS AND TEST EQUIPMENT.

1-4.4.1. SPECIAL TOOLS. No special tools are required for installation and maintenance of the wind measuring set.

1-4.4.2. TEST EQUIPMENT. Test equipment required for test and fault isolation of the wind measuring set is listed in table 1-4.

1-4.5. RELATED TECHNICAL MANUALS. Table 1-3 lists related technical manuals.

Table 1-3. Related Technical Manuals

Publication Number	Publication Title
T.O. 31M1-2FMQ13-1	Operations Instruction Manual for the Wind Measuring Set AN/FMQ-13(V)
T.O. 31M1-2FMQ13-3	Circuit Diagrams Manual for Wind Measuring Set AN/FMQ-13(V)
T.O. 31M1-2FMQ13-4	Illustrated Parts Breakdown for Wind Measuring Set AN/FMQ-13(V)
T.O. 31M1-1-06	Work Unit Code Manual for Wind Measuring Set AN/FMQ-13(V)
T.O. 31M1-2FMQ13-6WC-1	Scheduled Periodic Inspection Workcards for Measuring Set AN/FMQ-13(V)
T.O. 31S5-4-4019-12	Operator Manual, Printer Model ML184 Turbo (Okidata Commercial Manual)
T.O. 31S5-4-4019-12	Maintenance Manual, Printer Model ML184 Turbo (Okidata Commercial Manual)

Table 1-4. Test Equipment List

Manufacturer and Model No.	Nomenclature	Use
Fluke Model 77	Multimeter	Measurement of voltage and resistance.
Tektronix, Model 2213A	Oscilloscope	Waveform measurement.
Fluke, Model 9010A	Microprocessor Emulator	Off-equipment troubleshooting and testing of the microprocessor - controlled circuitry.
Tektronix Model P6401	Logic Probe	Monitors logic levels during on-equipment troubleshooting.
Universal Data System, Model 202T	Modem, Bell 202 Type	Used with a data communications protocol analyzer to monitor inter-assembly data communications or to provide test signals and response validation for complete indicator, recorder, and sensor assemblies.
Hewlett-Packard Model 4951B	Protocol Analyzer	Used in conjunction with a Bell 202-type modem to monitor inter-assembly data communications channel.

CHAPTER 2

INSTALLATION

Section I. INSTALLATION LOGISTICS

2-1 UNPACKING AND INSPECTION.

Unpack and inspect the wind measuring set as follows:

a. Immediately upon receipt of the wind measuring set, inspect the shipping cartons for damage. If damage is evident, report it to the carrier and The Sutron Corporation.

b. Carefully open the carton and inspect the equipment for damage. Refer to paragraph 5-7.4.1 of this T.O. before inspecting the sensor. If the equipment has been damaged, report the damage in accordance with local procedures.

c. Check to see that the equipment is complete as listed on the packing slip. Report all discrepancies in accordance with local procedures.

2-2 STORAGE.

If necessary to store the wind measuring set for any period of time before installing, store it in a shelter having the following environmental characteristics:

Temperature: -57 to 68 degrees C.

Altitude: -100 to 40,000 feet.

2-3 RECEIVING DATA.

Table 2-1 lists all items required to complete installation. This includes uncrated dimensions and weights of equipment and components, and lists all items required to complete installation including connectors and mounting hardware.

Table 2-1. Items Required to Complete Installation

Qty	Item	Dimensions (In.)			Weight (Lb)
		W	H	D	
1-4	Wind Direction and Speed Sensor Assembly ML-660/FMQ-13(V)	10.69	24.75	5.125	17
1-4	Ruggedized Wind Direction and Speed Sensor Assembly ML-660A/FMQ-13(V)	10.69	24.75	5.125	17
1-16	Digital Display Indicator ID-2408/FMQ-13(V)	19.0	6.97	6.5	11
1-16	Wind Direction and Speed Recorder RO-588/FMQ-13(V)	19.0	15.12	21.8	27

NOTE: Connectors and mounting hardware will be included

2-4 MATERIAL HANDLING.

No material handling equipment is required in the installation of the wind measuring set.

2-5 CABLES/INTERCONNECTING WIRING.

Table 2-2 lists all externally located cables and wiring.

Table 2-2. Wind Measuring Set External Cables/Interconnecting Wiring

Connector/Terminal Block	External Cable/Wiring
Sensor	
Terminal block	Five wires (three wires connect to AC power source; two wires connect to inter-assembly wiring).
Indicator	
AC POWER connector	AC power cable.
AWDS connector	AWDS wiring.
INTER-ASSEMBLY COMMUNICATIONS connector	Inter-assembly wiring.
Recorder	
AC IN connector	AC power cable.
AC OUT connector	Printer power cable assembly.
PRINTER connector	Printer interface cable assembly.
AWDS connector	AWDS wiring.
INTER-ASSEMBLY COMMUNICATIONS connector	Inter-assembly wiring.

2-6 BUILDING AND OTHER SUPPORTING STRUCTURES.

The power, heating/ventilation, and air conditioning/heat dissipation requirements for the structures housing the wind measuring set indicator and recorder assemblies are as follows:

Power Requirements .....115/230V, 47-63 Hz, 200 watts maximum per assembly.

Air Conditioning and Heat Dissipation.....781 BTUs per assembly.

Heating and Ventilation.....Heating and ventilation must be provided to maintain the operating environment within the temperature range 0 to +49 degrees C.

Section II. INSTALLATION PROCEDURES

2-7 INTRODUCTION.

A total of four sensors can be used in any one wind measuring set installation. They are installed on existing stubs mounted on a concrete foundation at the end of the runways. Up to sixteen indicators and/or recorders may be used in the weather station or other locations where a knowledge of field weather conditions would be useful. Inter-assembly wiring is often ducted. Prior to installing the wind measuring set as described in paragraph 2-10, review the installation planning information in paragraph 2-8 and perform the pre-installation setup and checks given in paragraph 2-9.

2-8 INSTALLATION PLANNING.

Paragraphs 2-8.1 through 2-8.5 provide planning considerations which should be thoroughly reviewed prior to installation of the wind measuring set.

2-8.1 **Transmission Medium**. Either of three types of inter-assembly wiring can be used to carry signals between the sensor, indicator, and recorder assemblies of the wind measuring set. They are:

a. A single pair of standard 3002, basic conditioned voiceband private line telephone data channels as described in DCA Circular 300-175-0, Enclosure 1, Table 1 and Enclosure 2, Tables 1, 2, 3, and 7.

b. Dedicated, voice quality, 24 AWG telephone-type cable.

c. Meteorological cable (12 conductor, 12 AWG shielded).

2-8.2 **Inter-Assembly Wiring Configuration**. The inter-assembly wiring consists of four signal conductors: D1(T), D2(R), T1(T), and T2(R). These four wires must be connected in parallel to all sensors, indicators, and recorders as shown in FIGURE 2-1a. FIGURE 2-1b is a simplified representation of the inter-assembly wiring configuration, using a single line to represent all four wires and shows a single "T" junction to represent "T" junctions on all four wires.

The topology of the wiring is termed a "star" as shown in FIGURE 2-2. It consists of a number of long wire lengths, called legs, tied together at a central junction or 'hub'. Short wire lengths, called stubs, branch off from a leg to connect an assembly.

All private lines must be tied into the hub, and are considered legs of 24-gauge wire type in calculations below.

When an assembly transmits data to another assembly, the signal loses strength, or undergoes 'loss' in three parts: first, traveling in one leg to the hub; second, crossing the hub; and third, traveling out another leg to the destination. The loss from these three parts are expressed in decibels, and may be added to calculate the total loss from source to destination. The transmitted signal strength will be 0 dBmw (1 milliwatt) and must be received at no less than -36 dBmw to be received reliably. The resulting maximum loss of 36 dB is divided among the three parts described above, as shown in FIGURE 2-3.

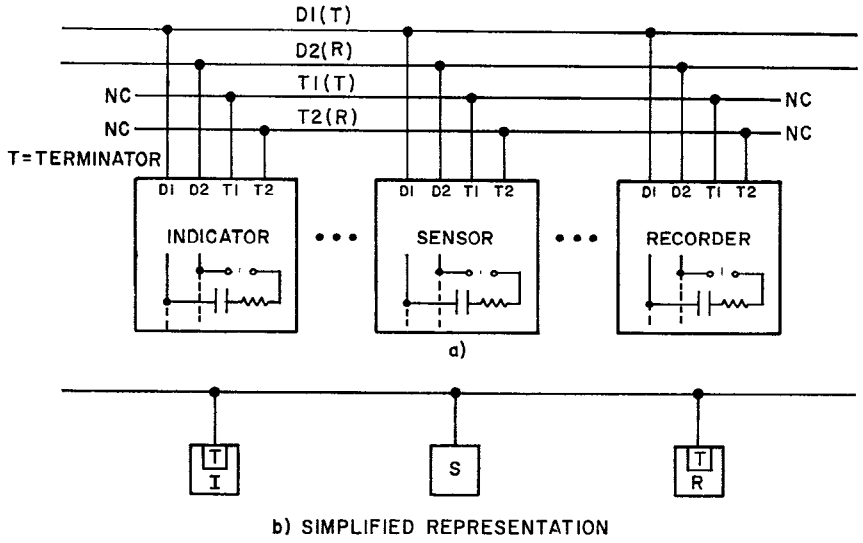


FIGURE 2-1. Inter-Assembly Wiring, Four Wire Parallel Connection

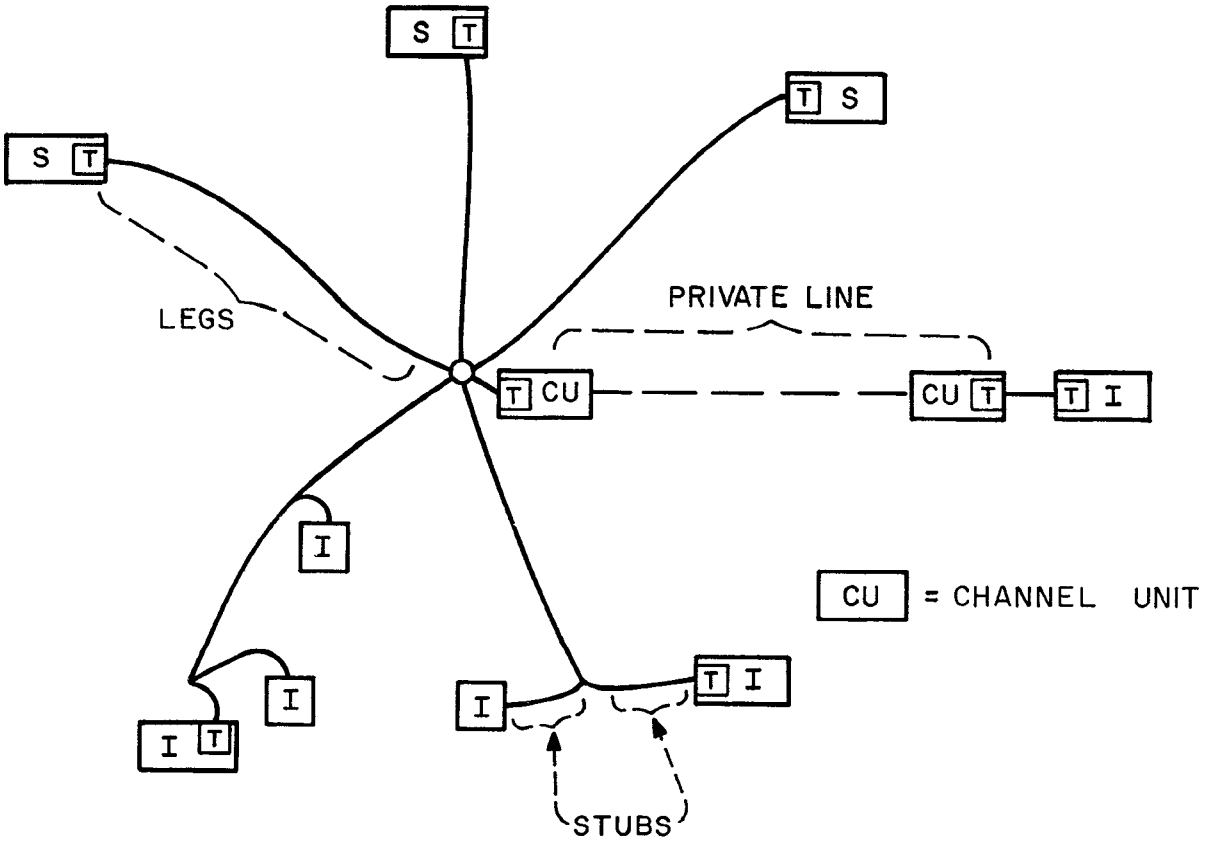


FIGURE 2-2. Inter-Assembly Wiring, Star Topology

ALLOCATION OF LOSS			
SOURCES OF LOSS	CASE I	CASE II	CASE III
INBOUND LEG	8 DB	16 DB[1]	16 DB
HUB	20 DB	12 DB	4 DB
OUTBOUND LEG	8 DB	8 DB	16 DB
TOTAL LOSS	36 DB	36 DB	36 DB

[1]THE 16 DB PRIVATE-LINE LOSS IS ARBITARILY SHOWN ON THE INBOUND LEG, THOUGH IT OCCURS ON THE OUTBOUND LEG, AS WELL, BUT NOT ON BOTH

CASE I — NO PRIVATE LINES, OR PRIVATE LINE LOSS ADJUSTED TO 8 DB LOSS.

CASE II — ONE PRIVATE LINE WITH 16 DB LOSS.

CASE III — TWO PRIVATE LINES WITH 16 DB LOSS EACH.

DISTANCE FOR 8 DB LOSS — 12 & 24 AWG	
24 AWG TELEPHONE PAIR	12,000 FT.
12 AWG METEROLOGICAL CABLE	74,000 FT.

FIGURE 2-3. Loss budget

Case 1 of FIGURE 2-3 is expected to cover the vast majority of cases. Here 8 dB of loss is allotted to each leg; a leg wired with 24 AWG can be up to 12,000 feet long and a 12 AWG leg can be up to 74,000 feet long. The loss due to the hub varies with the number and gauge of the legs, and may be up to 20 dB. For example, four 24 gauge legs and four 12 gauge legs result in just under 20.0 dB loss. The hub loss does not appear all at once right at the hub; rather, it is distributed along the inbound leg, due to the impedance change that does occur all at once at the hub.

2-8.3 **Location of Assemblies**. Identify location of all sensors, indicators, and recorders comprising the wind measuring set. Locate the sensors using the following as a guide:

a. Locate all assemblies so as not to exceed allowed wire lengths and loses. Otherwise, the signal strength at the remote end of the line will not be adequate.

b. Locate all assemblies in a "star" topology as shown in FIGURE 2-2.

c. Locate assemblies convenient to AC power source. Plan for additional power distribution.

d. Plan mechanical support for each assembly. Sensors are mounted on existing mast. Indicators require a rack/console; recorders require a 19-inch rack.

e. Determine which indicator AWDS port(s) will be utilized.

f. Locate sensors in areas of flat terrain.

g. Locate sensors in open areas away from any wind obstructions.

h. Locate sensors away from any wind sources (i.e. moving vehicles, fans, etc.).

2-8.4 **Designate Master and Backup Indicators**. In a minimum system (one sensor and one recorder), the recorder CONFIGURATION switch is set to MASTER. On all other system configurations, one indicator is designated as master, a second indicator is designated backup, and all remaining indicators and recorders are designated regular. The master indicator is typically located at the place used to assign runways where planes are going to take off and land. The master indicator is used to change the active sensor. Any indicator or recorder can be designated as backup.

2-8.5 **Wiring Rules**. Plan inter-assembly wiring configuration including lengths, gauge, and type of wiring using the following wiring rules as a guide:

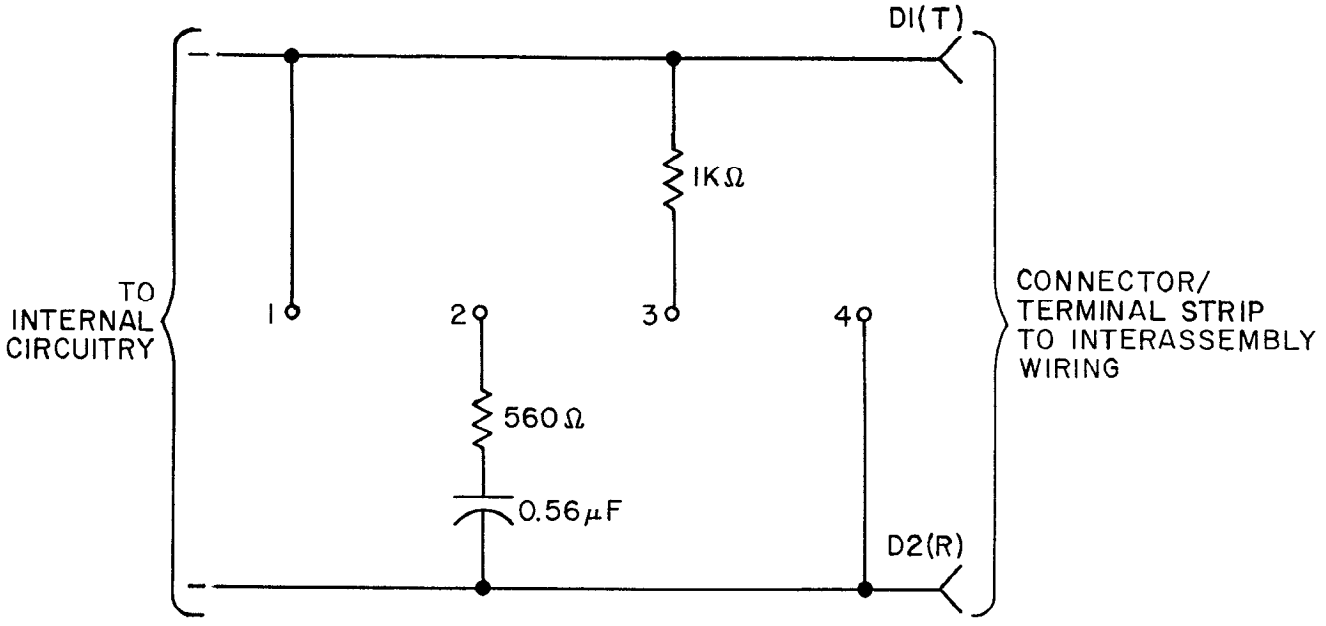
2-8.5.1 **Legs**. The following rules must be followed in wiring each leg to assure predictable loss.

a. A leg must be wired using one type of cable, except that lengths under 1,000 feet of a different type may be used as stubs, and a single segment under 1,000 feet of another type may be used as part of any leg. Two types of wire are presently allowed: 24-AWG telephone pair and 12-AWG meteorological cable.

b. The total length of a leg, measured from the hub to the assembly farthest away, must be less than specified in FIGURE 2-3.

c. Each leg must be terminated by installing the appropriate terminating network jumpers in the assembly at the end of the leg. FIGURE 2-4 shows the termination network jumper options for different wire gauges. The jumper options provide a range of different termination impedances from 1.56 kilo-ohms down to 359 ohms to approximately match the characteristic impedance of the inter-assembly wiring used and thereby control reflections. At present, only two of the four different impedance values available are specified to cover wire from 12 to 26 AWG. When further experience with different wiring types has been gained, these jumper options may be revised to use the remaining values.

d. Each assembly may be connected to its leg at any point along its length by a stub less than 1,000 feet.



TERMINATOR JUMPER FIELD

JUMPER PINS CONNECTED	RESULTING TERMINATION IMPEDANCE	APPLICATION SITUATION
None	Open (00	Not end of leg
2 to 3	1.56K ohms and 0.56 uF inter-assembly wiring	End of leg, 20-26 AWG
3 to 4	1K ohms inter-assembly wiring	End of leg, 12-19 AWG
1 to 2	560 ohms and 0.56 uF	Reserved
1 to 2 and 3 to 4	359 ohms and 0.56 uF	Reserved

FIGURE 2-4. Termination Jumpers in Sensor, Indicator, Recorder

2-8.5.2 **Hubs**. FIGURE 2-5 shows the loss predicted due to the impedance change at the hub for different numbers and types of legs. To determine the hub loss for a particular wiring configuration, count the number of legs of each cable type, and find the corresponding loss value from the table. For case I, the loss value must be less than 20 dB. All of the connections at the hub should be within 100 feet of each other.

CASE I BOUNDARY

← LOSS ≤ 20 DB → ← LOSS > 20 DB →

NO. OF 24-AWG LEGS (NWI)

LOSS IN DB		0	1	2	3	4	5	6	7	8	9	10	11	12
	0			0.0	3.5	6.0	8.0	9.5	10.9	12.0	13.1	14.0	14.8	15.6
	1		7.9	9.5	10.8	12.0	13.0	13.9	14.8	15.5	16.2	16.9	17.5	18.0
	2	0.0	13.0	14.0	14.8	15.5	16.2	16.9	17.5	18.0	18.6	19.1	19.5	20.0
NO.	3	3.5	16.2	16.9	17.5	18.0	18.6	19.1	19.5	20.0	20.4	20.8	21.2	21.5
OF	4	6.0	18.6	19.1	19.5	20.0	20.4	20.8	21.2	21.6	21.9	22.2	22.6	22.9
12-AWK	5	8.0	20.4	20.8	21.2	21.6	21.9	22.3	22.6	22.9	>	>	>	>
LEGS	6	9.5	21.9	22.3	22.6	22.9	>	>	>	>	>	>	>	>
(NW2)	7	10.9	>	>	>	>	>	>	>	>	>	>	>	>
	8	12.0	>	>	>	>	>	>	>	>	>	>	>	>
	9	13.1	>	>	>	>	>	>	>	>	>	>	>	>
	10	14.0	>	>	>	>	>	>	>	>	>	>	>	>
	11	14.8	>	>	>	>	>	>	>	>	>	>	>	>
	12	15.6	>	>	>	>	>	>	>	>	>	>	>	>

>= LOSS GREATER THAN 20dB

FIGURE 2-5. Hub Loss vs. No. and Type of Legs 2-9

2-8.5.3 **Private Lines**. Standard 3002 voice-grade private lines are adjusted to a loss level of 16 dB by the provider by means of installation wiring options. With this high a loss value, much less loss is left to be allocated to the hub, as shown in FIGURE 2-3, cases II and III. In FIGURE 2-5, it can be seen that in case III, with two private lines (each of which counts as a 24-AWG leg) no other legs are allowed. In case II, which has one private line, only one 12-AWG leg, or two additional 24-AWG legs are permitted.

If these constraints are too restrictive, the following solutions may be pursued:

a. Request the provider of the private line to adjust its loss to a value lower than 16 dB, such as 8 dB, which makes them fit Case I, and greatly eases the configuration.

b. Add a repeater to boost the signal level where each private line meets the hub

c. Connect all assemblies in a system using a conference multi-point private line channel. This type of private line can link upwards of twenty assemblies and is a well-known standard private-line service available through Bell and independent telephone companies. This would eliminate loss problems, since the hub and its corresponding loss would be replaced by the private line active bridge circuits. The disadvantage of this approach is its lowered reliability; a fault in the private line circuits can bring down the whole system. The leasing charges for private lines can be considerable as well. The total propagation delay of the private line must be less than 50 milliseconds one way. This requirement precludes the use of any geosynchronous satellite circuits in a private line. However, using terrestrial circuits, the delay requirement limits the private line roughly under 5,000 miles in length. The exact length is a function of the type of transmission facility used, and can vary widely.

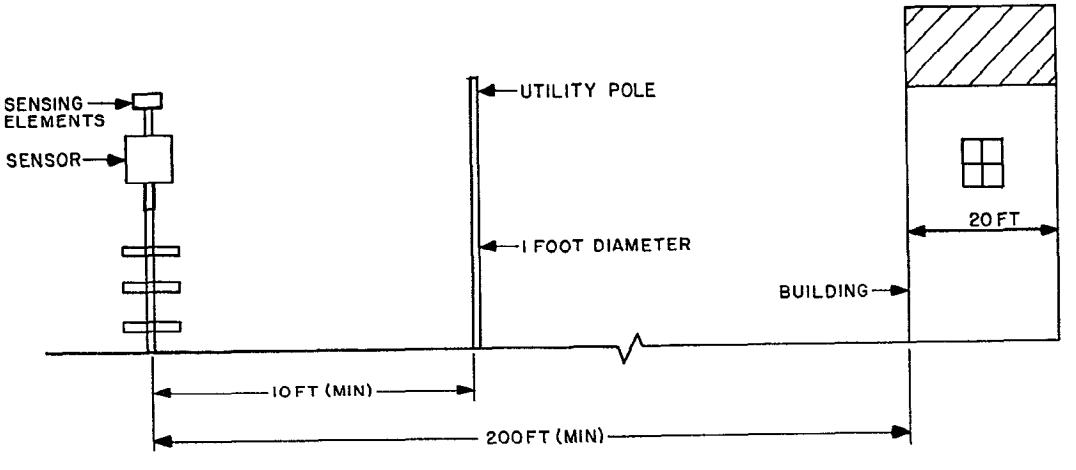


FIGURE 2-6 Distance-To-Diameter Ratio of 10

2-8.6 **Obstructions**. Site selection of the sensor should take potential obstructions to air flow into account. There should be no obstructions within 2 feet of the same elevation of the sensing elements out to a radius of 2 feet. Potential obstructions beyond the 2 foot radius should comply with distance-to-diameter ratio of 10. (See FIGURE 2-6.) This means that an obstruction near the same elevation of the sensor which is 1 foot in diameter should be a minimum of 10 feet away from the sensor, Another example would be a building which is 20 feet across and which is tall enough to be near or above the elevation of the sensor. In this example, the building should be a minimum of 200 feet distance from the sensor.

2-9 PRE-INSTALLATION SETUP AND CHECK.

Paragraphs 2-9.1 and 2-9.2 describe setup and check procedures which should be made prior to installing the wind measuring set.

2-9.1 **Verifying/Setting Jumpers**. Various PCBAs in the sensor, indicator, and recorder use jumpers to configure the wind measuring set for desired operational parameters. The jumpers are factory preset, but must be checked to ensure that strapping is correct for the applicable installation.

2-9.1.1 **Indicator/Recorder**. Verify/set jumpers on indicator/recorder interconnection and microprocessor PCBAs as follows:

2-9.1.1.1 **General**. Perform the following procedure to gain access to the PCBAs:

a. Turn equipment power off.

b. Remove top cover of indicator (dash 1 or dash 2, as applicable) by removing attaching screws.

c. Remove microprocessor PCBA from the display chassis to gain access to the interconnection PCBA.

2-9.1.1.2 **Interconnection PCBA**. (See FO-1.) The interconnection PCBA uses the following jumpers: AC Power Voltage Strapping, Inter-Assembly Termination, Number of Sensors, and 2/10 Minute Averaging. Verify that these jumpers are properly connected as follows:

a. **AC Power Voltage Strapping**. Jumper E32 allows configuring the indicator/recorder for either 115V or 230V operation. The indicator/recorder is shipped from the factory with E32 strapped for 115V operation. Verify that E32 is strapped for 115V or 230V operation by referring to FIGURE FO-1 and table 2-3.

Table 2-3. Interconnection PCBA AC Power Voltage Strapping

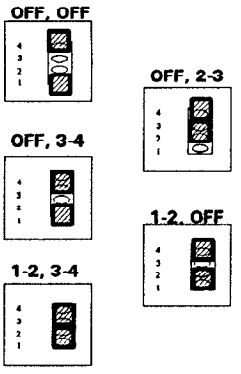
E32 Strapping			
115 VAC		230 VAC	
FROM	TO	FROM	TO
E32-1	E32-4	E32-1	E32-2
E32-2	E32-3	E32-3	E32-6
E32-5	E32-6	E32-4	E32-5

b. **Inter-Assembly Termination Strapping**. Terminator networks may be added at certain points of the inter-assembly wiring across D1(T) and D2(R) via jumper E33 on the interconnection PCBA. This termination depends on where the assembly is located on the inter-assembly wiring. The rules for determining when to stop in a termination network are described in paragraph 2-8, and are reasonably complex. Therefore, the termination network strapping should be planned in advance by a planner familiar with paragraph 2-8 and the overall installation plan. The strapping assignments should be documented for each assembly for later use by other personnel less familiar with the installation plan The terminator network strapped depends on the inter-assembly wire size; 12 AWG wire will require a lower termination impedance than 24 AWG wire. FO-1 shows a simplified schematic of the termination network used on each interconnection PCBA. It is basically a resistor which is used to restrict reflections that could cause the modem in the indicator/recorder to operate improperly

Table 2-4 indicates how to strap E33 depending on whether the inter-assembly wiring is 12-19 AWG or 20-26 AWG. If the indicator/recorder is to be installed in a building with other assemblies, only the assembly at the end of the line will need to be terminated The equipment is shipped from the factory with jumpers installed in the OFF/OFF position.

Table 2-4. Interconnection PCBA Inter-Assembly Termination Strapping

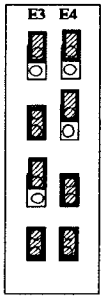
E33 Position	Function
OFF, OFF	OPEN - NOT AT END OF LEG
OFF, 2-3	1.56K OHMS - END OF LEG, 20-26 AWG INTER-ASSEMBLY WIRING
OFF, 3-4	1K OHM - END OF LEG, 12-19 AWG INTER-ASSEMBLY WIRING
1-2, OFF	560 OHMS - RESERVED
1-2, 3-4	359 OHMS - RESERVED



c. **Number of Sensors**. The wind measuring set can use from one to four sensors. Jumpers E3 and E4 must be strapped in accordance with table 2-5 depending on the number of sensors used in the system.

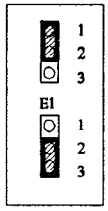
Table 2-5. Interconnection PCBA Number of Sensors Strapping

E3, E4 Position	Function
OFF, OFF	1 SENSOR
ON, OFF	2 SENSORS
OFF, ON	3 SENSORS
ON, ON	4 SENSORS



d. **2 or 10 Minute Averaging**. Jumper E1 allows configuring the recorder for either 2 or 10 minute averaging. Each assembly is shipped from the factory with E1 strapped for 2 minute averaging. Verify that E1 is strapped for the desired wind averaging as indicated in table 2-6. (This function is enabled on the recorder assembly only).

Table 2-6. Interconnection PCBA 2 or 10 Minute Averaging Strapping

E1 Position	Function	
1-2	2-MINUTE AVERAGING	
2-3	10-MINUTE AVERAGING	

2-9.1.1.3 **Microprocessor PCBA**. (See FO-2.) The microprocessor PCBA uses the following jumpers: Battery Enable, Watchdog Enable, and Carrier On. Verify that these jumpers are properly connected as follows:

a. **Battery Enable**. Jumper E1 allows enabling the Battery Backup circuit. During shipping and storage of the indicator/recorder (or microprocessor PCBA), E1 should be disconnected to conserve battery life.

b. **Watchdog Enable**. Watchdog Enable jumper E4 should be in the Enabled position (i.e. E4, pin 2 jumpered to pin 3) during normal operation. The watchdog may be disabled when needed for testing by jumpering E4, pin 2 to pin 1.

c. **Carrier On**. During normal operation, the Carrier On jumper (E5) must be disconnected, allowing the microprocessor to enable and disable carrier as needed. The jumper should be placed on only one of E5's pins, providing a convenient storage position for the jumper. DO NOT connect E5 in a working wind measuring set because it will cause the entire system to stop normal communications and display of the latest wind data. E5 may be connected for testing an individual assembly that is disconnected from a system's inter-assembly wiring, or for testing the inter-assembly wiring of a non-operational system during initial system installation or when the entire system is down due to a wiring fault. For testing, pins 1 and 2 may be connected, which turns on the modem carrier continuously, allowing easy oscilloscope viewing.

2-9.1.2 **Sensor**. Verify/set jumpers on sensor power-front and microprocessor A PCBAs as follows:

2-9.1.2.1 General. Perform the following procedure to gain access to the PCBAs:

a. Turn equipment power off.

b. The power-front PCBA is located in the sensor power assembly. Open front cover to gain access to PCBA.

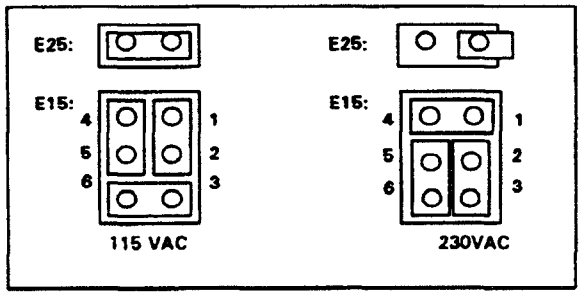
c. The microprocessor PCBA is located in the sensor control assembly. Open front cover to gain access to PCBA.

2-9.1.2.2. POWER-FRONT PCBA. (See FO-3) The power-front PCBA uses the following jumpers: AC Power Voltage strapping, Inter-Assembly Termination, and Carrier On. Verify that these jumpers are properly connected as follows:

a. AC Power Voltage Strapping. Jumpers E15 and E25 allow configuring the sensor for either 115V or 230V operation. The sensor is shipped from the factory with E15 and E25 strapped for 115V operation. Verify that E15 and E25 are strapped for 115V or 230V operation as applicable by referring to FO-3 and table 2-7.

Table 2-7. Power-Front PCBA AC Power Voltage Strapping

E25 Strapping			
115 VAC		230 VAC	
FROM	TO	FROM	TO
E15-2	E15-3	E15-1	E15-2
E15-4	E15-5	E15-3	E15-4
E15-1	E15-6	E15-5	E15-6
E25-1	E25-2	E25-OFF	E25-OFF



AC POWER VOLTAGE STRAPPING

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b. Inter-Assembly Termination Strapping. Terminator networks may be added at certain points of the inter-assembly wiring across D1(T) and D2(R) via jumper E24 on the sensor-front PCBA. The termination depends on where the assembly is located on the inter-assembly wiring. The rules for determining when to strap in a termination network are described in paragraph 2-8 and are reasonably complex. Therefore, the termination network strapping should be planned in advance by a planner familiar with paragraph 2-8 and the overall installation plan. The strapping assignments should be documented for each assembly for later use by other personnel less familiar with the installation plan. The terminator network strapped depends on the inter-assembly wire size; 12 AWG wire will require a lower termination impedance than 24 AWG wire.

FO-3 shows a simplified schematic of the termination network used on each power-front PCBA. It is basically a resistor which is used to restrict that could cause the modem in the sensor not to operate properly.

Table 2-8 indicates how to strap E24 depending on whether the inter-assembly wiring is 12-19 AWG or 20-26 AWG. The equipment is shipped from the factory with no jumpers installed.

Table 2-8. Power-Front PCBA Inter-Assembly Termination Strapping

E24 Position	Function
OFF, OFF	OPEN - NOT END OF INTER-ASSEMBLY WIRING LEG
OFF, 2-3	1.56 OHMS - END OF LEG, 20-26 AWG INTER-ASSEMBLY WIRING
OFF, 3-4	1K OHMS - END OF LEG, 12-19 AWG INTER-ASSEMBLY WIRING
1-2, OFF	560 OHMS - RESERVED
1-2, 3-4	359 OHMS - RESERVED

c. **Carrier On**. During normal operation, the Carrier On jumper (E10) must be disconnected, allowing the microprocessor to enable and disable the carrier as needed. The jumper should be placed on only one of E10's pins, providing a convenient storage position for the jumper. DO NOT connect E10 in a working wind measuring set because it will cause the entire system to stop normal communications and display of the latest wind data. E10 may be connected for testing an individual assembly that is disconnected from a system's inter-assembly wiring, or for testing the inter-assembly wiring of a non-operational system during initial system installation or when the entire system is down due to a wiring fault. For testing, pins 1 and 2 may be connected, which turns on the modem carrier continuously, allowing easy oscilloscope viewing.

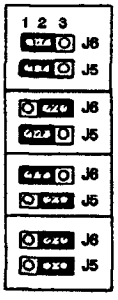
2-9.1.2.3. **Microprocessor A PCBA.** (See FO-4.) The microprocessor A PCBA uses the following jumpers: Watchdog Disable and Sensor Identification Number. Verify that these jumpers are properly connected as follows:

a. **Watchdog Disable**. Jumper J1 is the Watchdog Disable jumper. In operational modes, it should be disconnected.

b. **Sensor Identification Number.** Each sensor must be assigned a Sensor Identification (ID) number using jumpers J5 and J6 as shown in table 2-9.

Table 2-9. Sensor Microprocessor A PCBA Sensor Identification Number Strapping

Sensor ID	J5	J6
1	1-2	1-2
2	1-2	2-3
3	2-3	1-2
4	2-3	2-3



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NOTE: 1-2 implies that pins 1 and 2 of J5 or J6 are shorted and pins 2 and 3 are open.

2-9.2 **Setting Indicator/Recorder CONFIGURATION Switch**. Set the CONFIGURATION switch on the indicator and recorder as follows:

a. Set the CONFIGURATION switch on the master indicator or recorder to MASTER position. A recorder can only be the master in a minimum system (one sensor and a recorder).

b. Set the CONFIGURATION switch on the backup indicator to BACKUP position.

c. Set the CONFIGURATION switch on remaining indicators and recorders to REGULAR position. These indicators/recorders will display and/or record wind data from the active sensor selected by the master indicator/recorder.

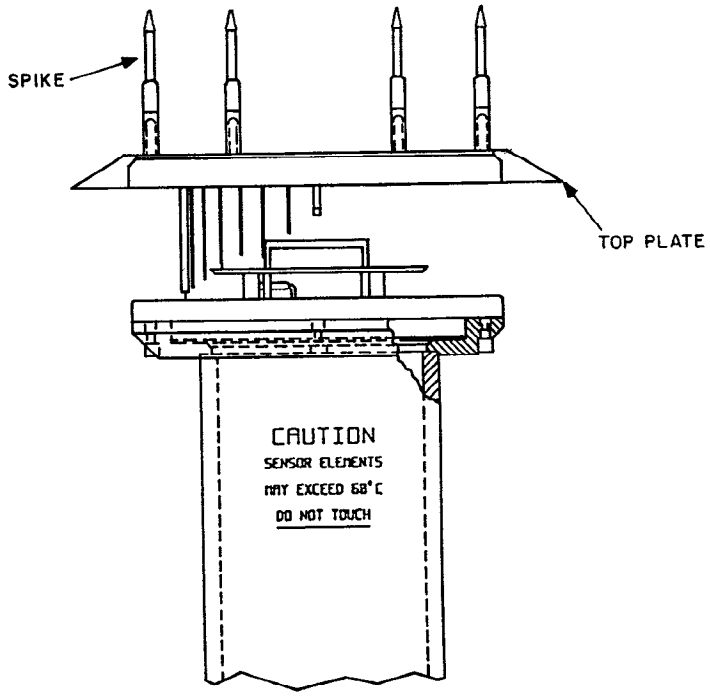
2-9.3 **Installation of Sensor Assembly Bird Spikes**. A complete sensor assembly includes bird spikes as shown in FIGURE 2-7. These spikes are used to secure the sensor top plate during normal operation. The sensor is shipped with the sensor top plate secured with three screws. The spikes are shipped with each sensor and are packaged as a set of six spikes. The bird spikes should be installed prior to installation of the sensor assembly on the mast as follows:

WARNING

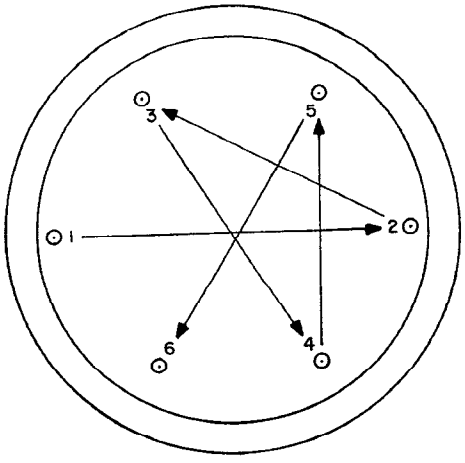
THE SPIKES ON TOP OF THE SENSOR HAVE SHARP POINTS. COVER SPIKES WITH SUITABLE PROTECTIVE MATERIAL. HANDLE SENSOR ASSEMBLY WITH CARE. FAILURE TO DO SO CAN CAUSE INJURY.

a. Remove the three screws securing the sensor top plate. Save the screws for use during reshipment.

b. Remove the top plate.



A. FRONT VIEW



B. TOP VIEW AND CRISS-CROSS PATTERN

FIGURE 2-7. Sensor Assembly Top Plate and Spike Installation

c. Verify that the cage top o-ring is installed in the o-ring channel.

NOTE

The bird spikes are fragile. Breakage can occur by overtighting and/or horizontal force.

d. Place top plate on cage top and secure with the six spikes using a criss-cross pattern as shown in FIGURE 2-7. After all spikes are finger tight, use a small adjustable wrench or vise grips to tighten one-quarter turn. This completes the installation of the bird spikes.

WARNING

THE SPIKES ON TOP OF THE SENSOR HAVE SHARP POINTS. COVER SPIKES WITH SUITABLE PROTECTIVE MATERIAL. HANDLE SENSOR ASSEMBLY WITH CARE. FAILURE TO DO SO CAN CAUSE INJURY.

2-10. INSTALLATION SEQUENCE.

Install the wind measuring set as follows:

WARNING

ENSURE THAT AC POWER HAS BEEN REMOVED FROM THE CABLE RUNNING THROUGH THE MOUNT. REMOVE AC VOLTAGE AT THE SOURCE. FAILURE TO DO SO CAN CAUSE INJURY OR DEATH.

a. Mount sensors on existing mounts as shown in FIGURE 2-8. Orient the sensor with the North indicator of the sensor pointing North. (Refer to FIGURE 2-9.) Tighten u-bolt hardware until sensor will not move freely. Perform final adjustment of the sensor to the North position by sighting down the lower element or the long side of the sensor chassis to the "North Mark" provided by support services engineering. Once the sensor is aligned, secure the u-bolt hardware to firmly clamp the sensor in place.

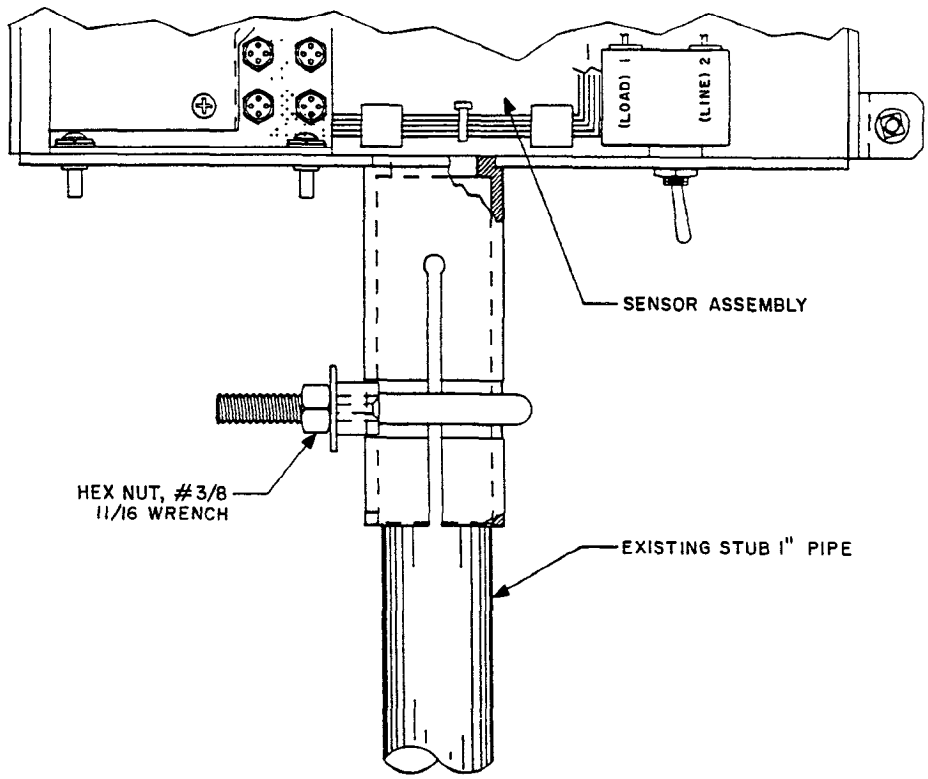


FIGURE 2-8. Installation of Sensor Assembly To Existing Stub Pipe

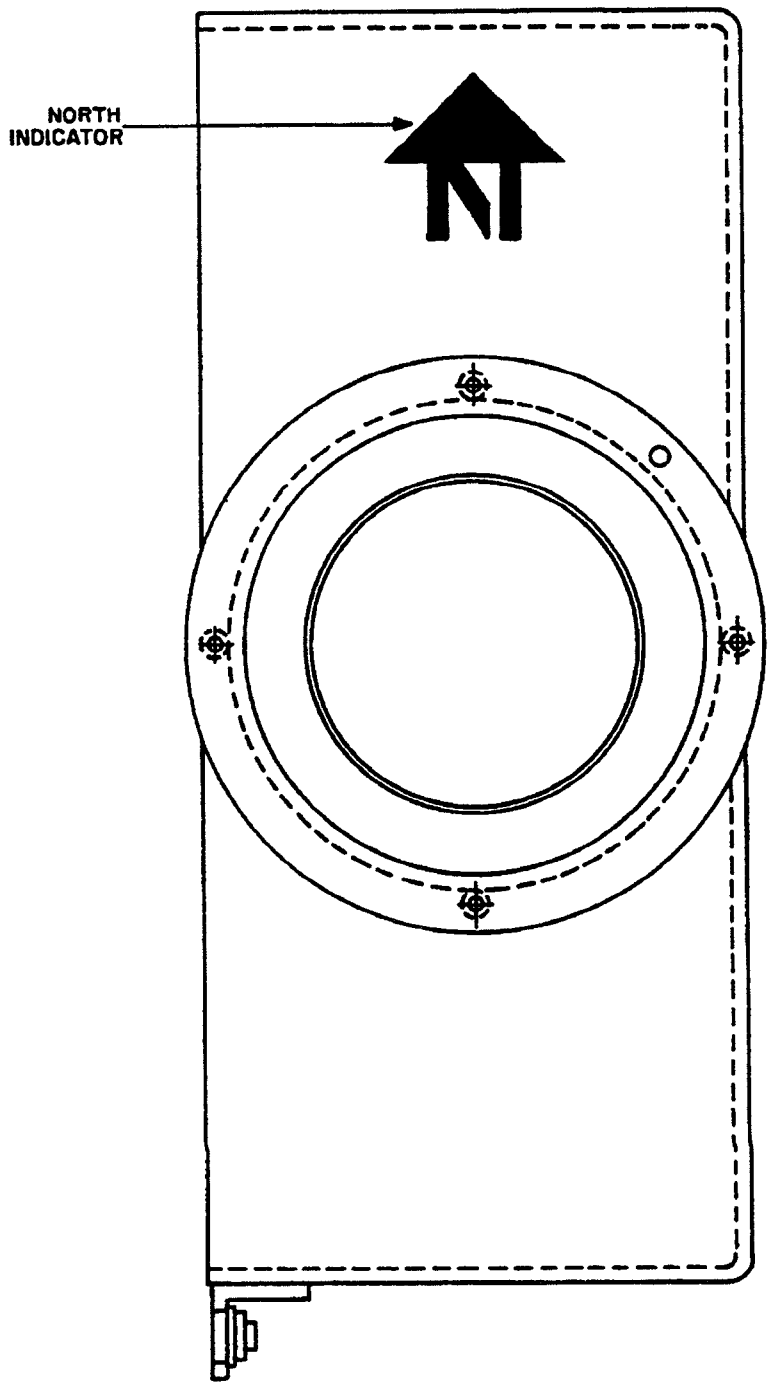


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Figure 2-9. Top View of Sensor Showing North Indicator

b. Open the door of the sensor power assembly and remove cover from the terminal block. Connect AC wiring [AC(POS), AC(NEG), AC(GND)] and inter-assembly wiring [D1(T) and D2(R)] to the terminal block as shown in FIGURE 2-10.

NOTE

Secure cover tightly to seal the enclosure.

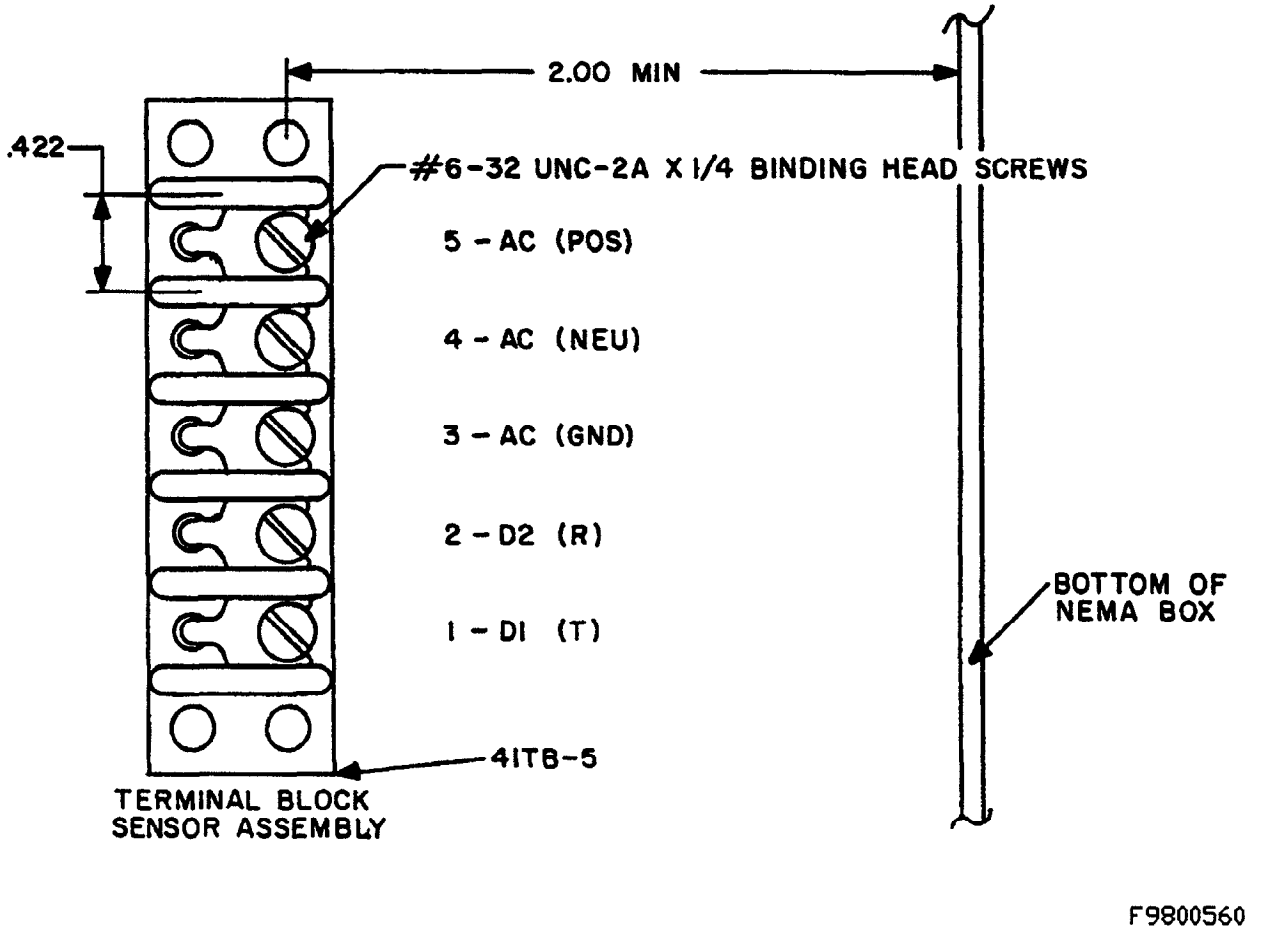

Figure 2-10. Electrical Connections to Terminal Block in Sensor Power Assembly

c. Mount stand-alone indicators in either a standard 19-inch rack or into a GMQ-20 indicator case at a 45 degree angle using four supplied screws and washers.

d. The indicator is provided with mating connectors for AC power and inter-assembly communications. Connect AC power as shown is FIGURE 2-11. Connect inter-assembly communications as shown in FIGURE 2-12.

e. The recorder installation uses a dash 2 version of the indicator, along with a printer and a printer chassis assembly which mount in a standard 19-inch rack as shown in FIGURE 2-13.

f. Referring to FIGURE 2-13, mount the dash 2 version indicator (4) in the 19-inch rack using the screws (4A) and washers (4B) supplied with the unit.

g. Attach the GFE chassis slides to the printer chassis as shown in FIGURE 2-14 using the screws, washers, and nuts supplied with the slides. (FIGURE 2-14 shows and exploded view of the printer chassis assembly. The chassis (1) is shipped completely assembled.)

h. Install cable tie-down pads (13) in two places as shown in FIGURE 2-14.

i. Install printer chassis in rack on slides. Pull printer chassis out of rack on the slides to gain access to install the printer.

j. Install printer (3) into printer chassis (1) as follows (refer to FIGURE 2-13):

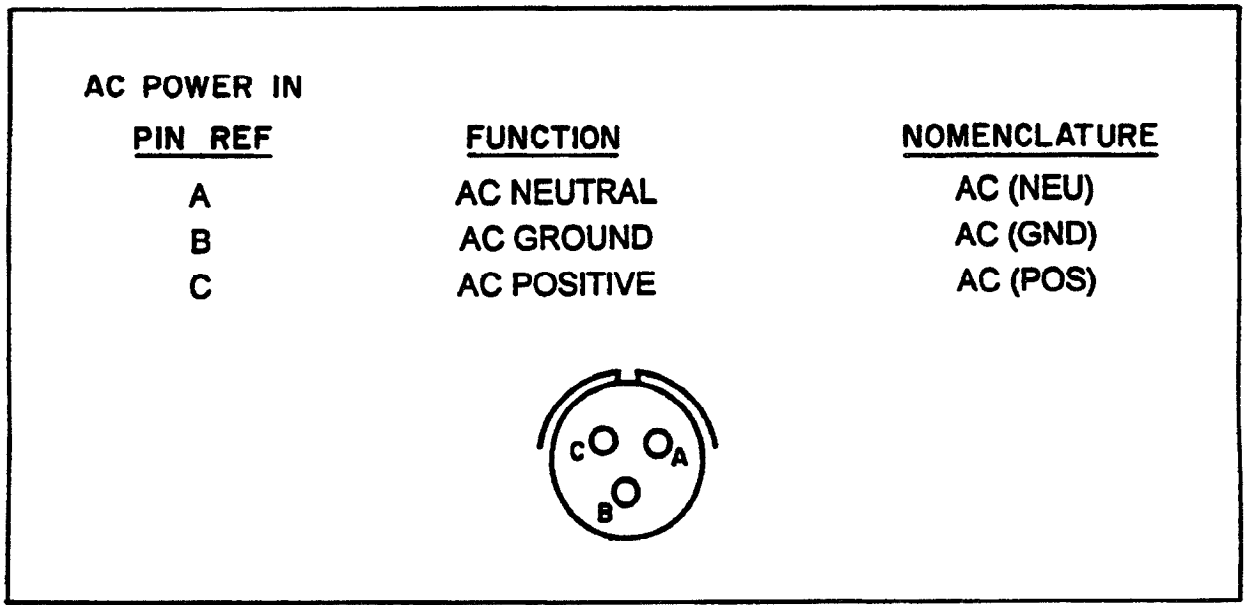

Figure 2-11. Indicator/Recorder Rear Panel Connections - AC Power In

INTER-ASSEMBLY COMMUNICATIONS

PIN REF	FUNCTION	NOMENCLATURE
A	DATA TIP	D1 (T)
B	DATA RING	D2 (R)
C	TEL. TIP	T1 (T)
D	TEL. RING	T2 (R)
E	SPARE	SP
F	SPARE	SP

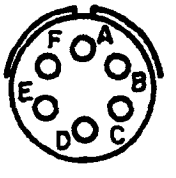

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Figure 2-12. Indicator/Recorder Rear Panel Connections - Inter-Assembly Communications

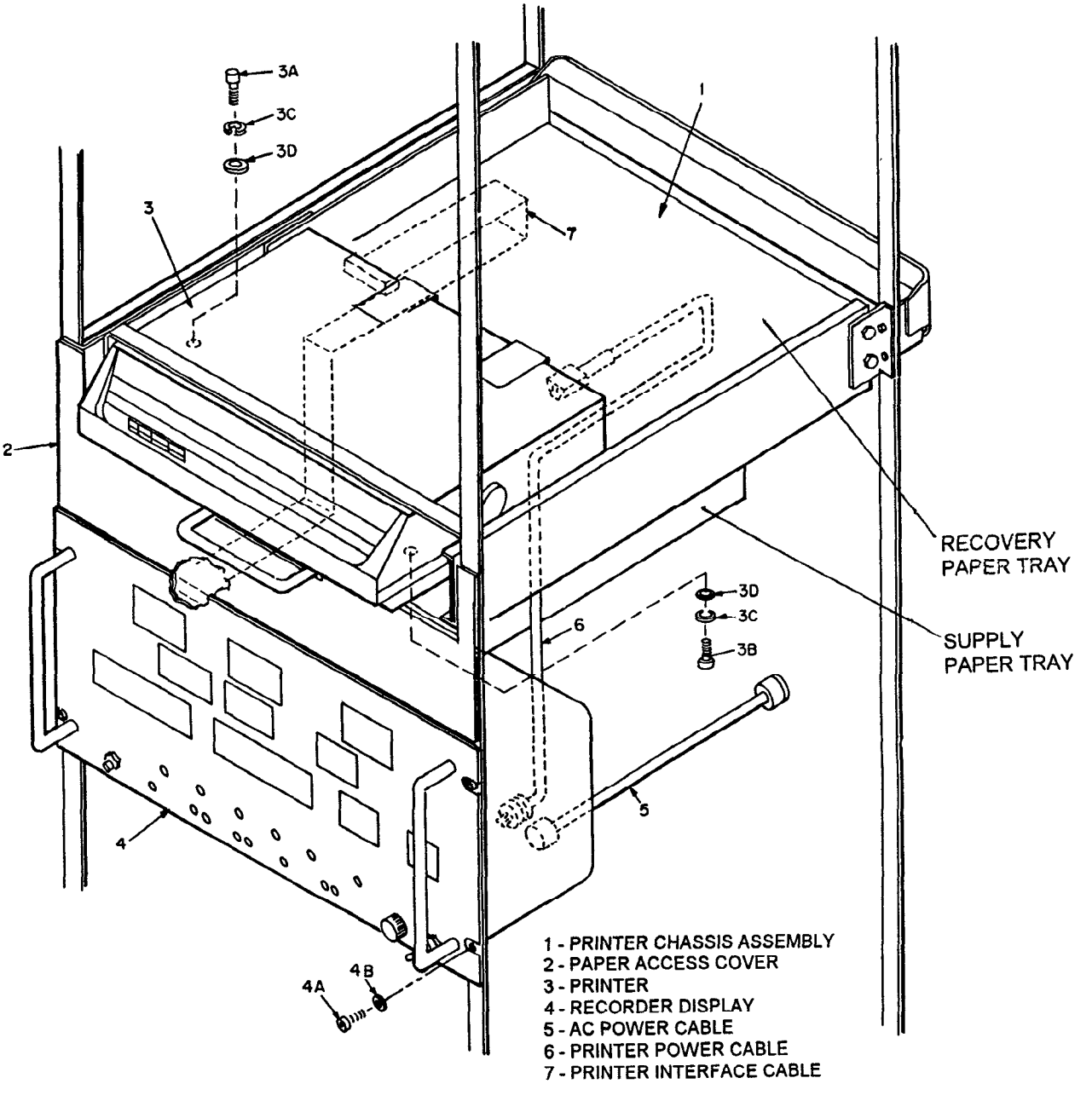


FIGURE 2-13. Installation of Wind Direction and Speed Recorder RO-588/FMQ-13(V)

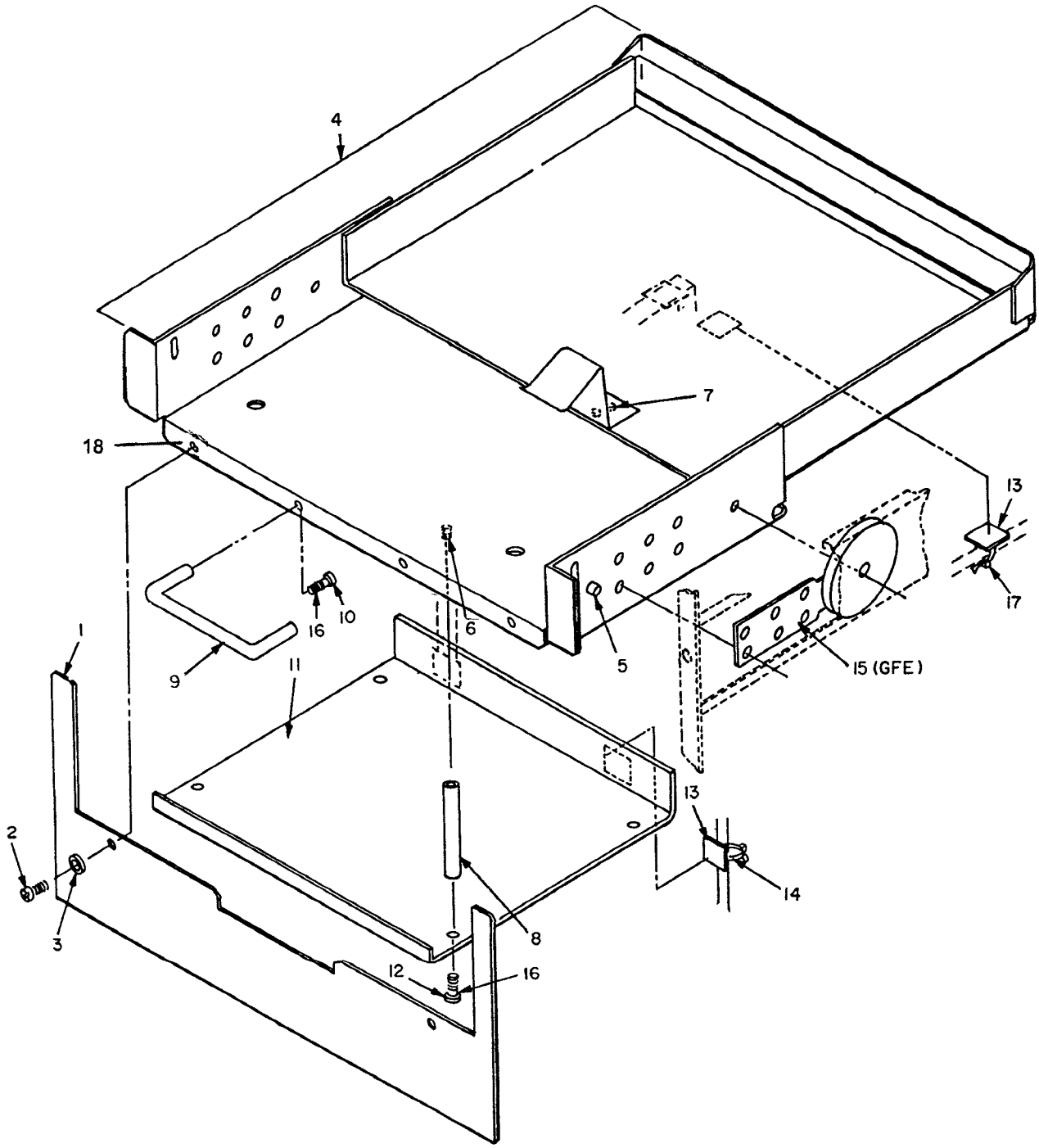


FIGURE 2-14. Installation of Printer Chassis Assembly and Paper Access Cover

(1) Remove two screws and associated hardware (3B, 3C, and 3D) located at the bottom front corners of the printer.

(2) Place the printer (3) on the printer chassis assembly (1). Position the printer so that the four feet mate with the four location holes of the printer chassis assembly.

(3) Install two screws removed in step 1 (3B, 3C, 3D) through the printer chassis assembly and into the printer to secure the printer (3) to the printer chassis assembly (1).

k. Install paper supply as follows (refer to FIGURE 2-13):

(1) Place fan-fold paper in the paper supply tray.

(2) Remove printer access cover (P/O 3) and lift the paper bail.

(3) Open the paper lever located on top right of the printer just above the platen knob. (The paper lever must remain open for sprocket fed paper).

(4) Route the paper up through the bottom of the printer through the printer access slot.

(5) Slide the paper up until it appears in front of the platen.

(6) Align the holes on either side of the paper with the corresponding pins of the adjustable feeds on either side of the carriage.

(7) Lower the paper bail.

(8) Use the platen knob to advance the paper to the first printing line at the top of the second page.

(9) Replace the printer access cover, routing the paper through the slot in the cover.

(10) Use the platen knob to advance the paper until a minimum of two pages are resting in the paper recovery tray behind the printer.

l. Referring to FIGURE 2-14, secure the paper access panel to the printer chassis assembly with two expanding latches. Each latch consists of three pieces, a latch grommet, a plugger grommet, and a plunger. Install latch grommets (18) into holes on the front flange of the printer chassis assembly (4). Install plungers (2) into plugger grommets (3) through paper access cover (1).

CAUTION

When installing the paper access cover onto the printer chassis assembly, the grommets of the latches must be completely inserted into the latch holes of the printer chassis assembly. Be certain that the back of the access cover butts up against the flange of the printer chassis assembly before pushing the plunger in to expand the grommet. Failure to do so can cause the latch grommet to be damaged creating an ineffective latch.

m. Install the paper access cover (1) onto the printer chassis assembly (4) as shown in FIGURE 2-14. This is done by pulling the plunger out, positioning the paper access panel to engage the grommets into the latch holes, and pushing the plunger in to expand the latch.

Referring to FIGURE 2-13.

n. Connect the printer interface cable (7) between printer and indicator at connector marked "PRINTER A3J3".

o. Connect the printer power cable (6) between printer and indicator at connector marked "AC POWER J4".

p. Connect the AC power cable (5) to the connector marked "AC IN J2".

q. The dash 2 version of the indicator is provided with a mating connector inter-assembly communications. Connect to inter-assembly communications as shown in FIGURE 2-12.

r. Some installation sites may make use of the AWDS output port located on the rear panel of each indicator and recorder. Table 2-10 provides the pin definition for the AWDS Port, J4.

NOTE

This interface is configured as a send-only unit. The cable used to connect to the receiving unit should not use the receive data pins. These pin configurations should be left open. Failure to do so may cause erroneous BIT results.

Table 2-10. AWDS Port (J4) Pin Definitions

Pin #	Signal Name	Function
4	SDA	Send Data
6	RDA	Receive Data (Leave Open)
7	RSA	Request of Send
9	CSA	Clear to Send
11	DMA	Data Mode
18	TMA	Test Mode
20	RC	Receive Common
24	RDB	Receive Data (Leave Open)
27	CSB	Clear to Open
29	DMB	Data Mode

CHAPTER 3

PREPARATION FOR USE AND RESHIPMENT

Section I. PREPARATION FOR USE

3-1 INTRODUCTION.

This section provides post-installation operational checks which must be performed prior to operating the wind measuring set. If the installation is using existing inter-assembly wiring, proceed to paragraph 3-2.3 after performing the preliminary procedure of paragraph 3-2.1. If new inter-assembly wiring is used in the installation, perform the procedure of paragraph 3-2.2.

3-2 OPERATIONAL CHECK.

Upon completion of the installation procedures in Chapter 2, perform the following procedure to ensure that the equipment is functioning properly.

NOTE

If a continuous abnormal indication is observed while performing the following checks, refer to Chapter 5 for maintenance.

3-2.1 **Preliminary.** Perform the following preliminary procedure to prepare the wind measuring set for post-installation operational check.

a. Ensure that each sensor, indicator, and recorder is connected to a primary power source (115V or 230V AC, as applicable).

b. Turn on all sensors by placing the POWER switch on the respective assembly in the ON position.

NOTE

An error code of 04 is normal during the first 24 hours after turning power on at any unit.

c. Turn on the master indicator or recorder by placing the POWER switch in the ON position. Clear any initial error conditions displayed during the first 30 seconds by depressing the STATUS CLEAR pushbutton.

d. Turn on the remaining indicators and recorders using the same procedure as step c. Clear any initial error conditions.

3-2.2 **Inter-Assembly Wiring Check.** Check the inter-assembly wiring as follows:

a. Disconnect the inter-assembly wiring from the INTER-ASSEMBLY COMMUNICATIONS connector on all indicators and recorders.

b. On one indicator (or recorder), connect the Carrier-On jumper (E5) on the microprocessor PCA.

c. Using an oscilloscope, check for a symmetrical sinewave across the D1(T) and D2(R) pins on the INTER-ASSEMBLY COMMUNICATIONS connector of the indicator for which the carrier turned on. This sinewave should have an amplitude of 0 dBm (2.2V peak-to-peak).

d. Reconnect the inter-assembly wiring to the INTER-ASSEMBLY COMMUNICATIONS connector on the indicator for which the carrier was turned on.

e. At the other indicators, recorders, and sensor locations, check for a similar sinewave across the D1(T) and D2(R) pins of the inter-assembly wiring at that location having an amplitude of -35 dBm (40 mv peak-to-peak) or greater.

f. Reconnect all inter-assembly wiring and disconnect the Carrier-On jumper.

3-2.3 **Indicator/Recorder Check.** Perform the following procedure to check each indicator and recorder, one at a time. The sensors are checked by monitoring wind information and STATUS display on the indicators and recorders.

a. Turn INTENSITY control full clockwise.

b. Depress and hold the LAMP TEST pushbutton. Verify that all 7-segment displays display a number 8.

c. Adjust the INTENSITY control from full clockwise (CW) to full counterclockwise (CCW) position. Ensure that INTENSITY control adjusts brightness from completely off (full ccw) to maximum brightness (full cw).

d. Select the status display mode by pressing the STATUS CLEAR pushbutton while holding the LAMP TEST pushbutton depressed.

e. While in the status display mode, press the SET/RUN pushbutton to initiate the display test. Verify that all 7-segment displays display a count-down sequence (i.e., 9,8,7,6,etc). At the end of the count down on the recorder only, the audible alarm will sound. For both indicator and recorder, the count-down sequence will continue until the SET/RUN pushbutton is pressed again to end the display test.

f. Use the SET/RUN pushbutton to select the set mode.

g. Continue pressing the FIELD SELECT pushbutton until the HOURS field of the TIME display blinks.

h. Use the UP and DOWN pushbuttons to enter the correct time in hours on the TIME display.

i. Use the FIELD SELECT pushbutton to select the MINUTES field of the TIME display.

j. Use the UP and DOWN pushbuttons to enter the correct time in minutes on the TIME display.

k. Use the FIELD SELECT pushbutton to select the SECONDS field of the TIME display.

l. Use the UP and DOWN pushbuttons to enter the correct time in seconds on the TIME display.

m. Set the SET/RUN pushbutton to the RUN mode. The TIME display will update automatically.

n. Observe the TIME display. Correct time is displayed, and display updates once each second.

o. Observe the STATUS display. Verify that 00 or 04 is displayed, indicating no error. Long term recovery will be in effect after initial turn-on. If an error code is displayed, maintenance is required. Refer to Chapter 5.

p. Verify that the ACTIVE SENSOR display displays the number of the active sensor.

q. Observe the printer printout at the recorder(s). Verify that time and date on the printout matches the displayed time and date. Columns on printout should be aligned.

3-2.4 **Sensor Check.** The sensor is tested by completely blocking the air flow to the sensor and verifying that the displayed wind speed is one knot or less. Air flow to the sensor can be blocked by placing a metal can or small plastic bag over the cage section of the sensor. (Such a device is referred to a "zero wind cap" or simply a "zero cap.") The zero cap must completely block air flow to the sensor. Since the displayed wind speed is a 2- minute average, a 2-minute waiting period should be observed after installing the zero cap prior to taking a test reading. After verifying that the displayed speed is 1 knot or less, remove the zero cap.

Section II. PREPARATION FOR RESHIPMENT

3-3 INTRODUCTION.

This section describes procedures for preparing assemblies of the wind measuring set for reshipment. Included are procedures for shutting down, disassembly, and repacking of the equipment.

3-4 DISASSEMBLY.

Prepare the sensor, indicator, or recorder for reshipment as described in the following paragraphs.

3-4.1 **Sensor.** Proceed as follows:

a. Place the POWER switch in OFF position. De-energize the AC power circuit that provides power to the sensor terminal strip.

b. Open the door of the sensor power assembly and remove cover from the terminal block.

c. Disconnect the AC [AC(POS), AC(NEV), and AC(GND)] and inter-assembly wiring [D1(T) and D2(R)] from the terminal block.

d. Loosen the heavy-duty U-bolt and lift entire assembly from mount.

3-4.2 **Indicator.** Proceed as follows:

a. Place the POWER switch in OFF position.

b. Disconnect the power, inter-assembly wiring, and AWDS cables from the rear of the indicator.

c. Remove the indicator from the 19-inch rack or indictor case by removing four attaching screws and washers and pull indicator from rack/case. Save mounting hardware for shipment with the indicator.

d. Remove the top cover and place the Battery Enable jumper (E1) on the microprocessor PCA in "off" position. Replace the top cover.

3-4.3 **Recorder.** The recorder installation includes a dash 2 indicator and a printer, each of which may be prepared for reshipment.

a. Disconnect the power, printer interface, inter-assembly wiring, and AWDS cables from rear of the indicator and printer, as applicable.

b. Pull the printer chassis assembly forward and remove the equipment slides. Remove printer from printer chassis.

c. Remove the indicator from the 19-inch rack by removing four attaching screws and washers and pull indicator from rack. Save mounting hardware for shipment with recorder.

d. Remove the top cover and place the Battery Enable jumper (E1) on microprocessor PCA in "off" position.

CHAPTER 4

OPERATION AND THEORY OF OPERATION

4-1. OPERATING INSTRUCTIONS.

Operate the wind measuring set as follows:

a. Turn on all sensors, indicators, and recorders in the following sequence:

(1) Turn on all sensors.

(2) Turn on master indicator/recorder.

(3) Clear initial start-up error by depressing the STATUS CLEAR pushbutton. Clear any secondary error that occurs during the first 30 seconds of operation.

(4) Turn on remaining indicators and recorders.

(5) Repeat step (3) for each indicator and recorder.

b. Allow approximately 10 minutes for the data base to initialize before continuing.

c. Press the LAMP TEST pushbutton on each indicator/recorder and observe that all indicators are lit and that all segments of all 7-segment displays are on. A number 8 is displayed on every display when all segments are active.

d. Select the status display mode by pressing the STATUS CLEAR pushbutton while holding the LAMP TEST pushbutton depressed.

e. While in the status display mode, press the SET/RUN pushbutton to initiate display test. Verify that all 7-segment displays display a count-down sequence (i.e., 9, 8, 7, 6, etc). At the end of the count down on the recorder only, the audible alarm will sound. For both indicator and recorder, the count-down sequence will continue until the SET/RUN pushbutton is pressed again to end the display test.

f. Adjust the respective INTENSITY control for desired brightness of front panel indicators and displays.

g. Verify that 00 or 04 is displayed on the STATUS display of each indicator/recorder, indicating no error. If an error code is displayed or any display flashes, have the maintenance activity correct the problem before continuing.

h. Set time and date on each indicator and recorder as described in paragraph 2-4 of the Operation Instruction Manual.

i. Horizontal wind speed (0 to 150 knots), wind direction (0 to 360 degrees), and maximum wind gust data is continuously displayed. The recorder can optimally display peak winds occurring within the past 10 minutes, 1 hour, or 24 hours (selected by the DISPLAY SELECT pushbuttons).

j. To momentarily monitor wind data on the indicator from a sensor other than the active sensor, press the SENSOR SELECT pushbutton (for the sensor whose wind information is to be displayed) without simultaneously pressing the ACTIVE SENSOR SELECT pushbutton. After approximately 1 minute, wind data from the active sensor will again be displayed.

4-2 THEORY OF OPERATION.

Refer to paragraph 1-3 of the Operation Instruction Manual (T.O. 31M1-2FMQ13-1) for a system application block diagram of the wind measuring set. A complete theory of operation for the wind measuring set is given in Chapter 3 of the Operation Instruction Manual (T.O. 31M1-2FMQ13-1).

CHAPTER 5

MAINTENANCE

Section I. ORGANIZATIONAL AND INTERMEDIATE MAINTENANCE

5-1 GENERAL.

This section contains all organizational and intermediate level service and maintenance procedures for the wind measuring set. It includes a list of maintenance support equipment, a list of test points, minimum performance test tables, voltage requirements and sources, alignment and adjustment procedures, removal and replacement procedures, periodic inspection procedures, and cleaning.

5-2 EQUIPMENT REQUIRED BUT NOT SUPPLIED.

Table 5-1 lists all support equipment required for organizational and intermediate maintenance of the wind measuring set. This table describes the operational characteristics of each piece of support equipment.

Table 5-1. Maintenance Support Equipment for Organizational and Intermediate Maintenance

Equipment Identification	Characteristics
Multimeter, Fluke Model 77, or equivalent	DC voltage range: -50V to +50V AC voltage range: 0.1V to 300 VAC RMS Accuracy: +/- 1% Resolution: +/- 1/2%
Oscilloscope, Tektronix Model 2213A	Bandwidth: 0 to 40 MHz Number of channels: 2 Vertical voltage range: 10 mV to 100V
Logic Probe, Tektronix Model P6401	Logic status: High, low, intermediate Signal status: Stable or pulsing

5-3 BUILT-IN TEST.

The wind measuring set has a BIT (Built-In Test) system which determines if there are any faults that would affect display accuracy. When a fault is detected, the last correct readings will remain unchanged and will flash at a rate of 1.0 +/-0.25 Hz. The STATUS display on the indicator or recorder detecting the fault will also flash, displaying a status code indicating the cause of the fault. Tables 5-2 and 5-3 indicate the equipment status of each general status code which can be displayed on the STATUS display. Pressing the STATUS CLEAR pushbutton will cause the STATUS display to stop flashing. However, the general status code will still be displayed if the fault remains. If a general status code indicating a fault is displayed, a detailed status may be obtained by entering the Status

Display Mode. The Status Display Mode is selected by depressing the STATUS CLEAR pushbutton while holding the LAMP TEST pushbutton depressed. This causes all displays to be blanked except the WIND DIRECTION, WIND SPEED, DIRECTION VARIABILITY, and GUSTS SPREAD displays which display a specific status code. FIGURES 5-1 and 5-2 show the assignments of these displays while in the Status Display Mode. When the Status Mode is selected, the TIME display flashes all zeros to alert the operator that the indicator/recorder is not in its operating Display Mode. Tables 5-4 through 5-12 define equipment status for all possible Status Display Modes which can be displayed on the WIND DIRECTION, WIND SPEED, DIRECTION VARIABILITY, and GUSTS SPREAD displays. The following paragraphs describe the built-in test performed.

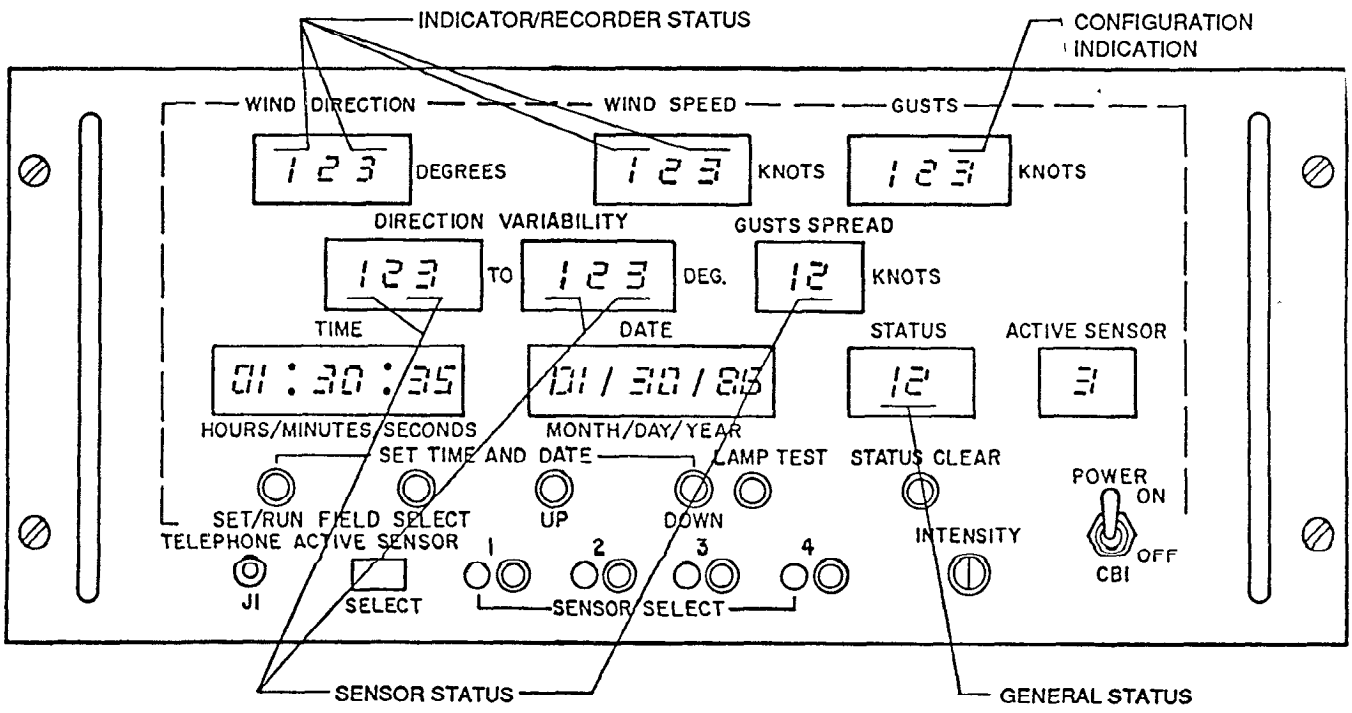


FIGURE 5-1. Error Code Display

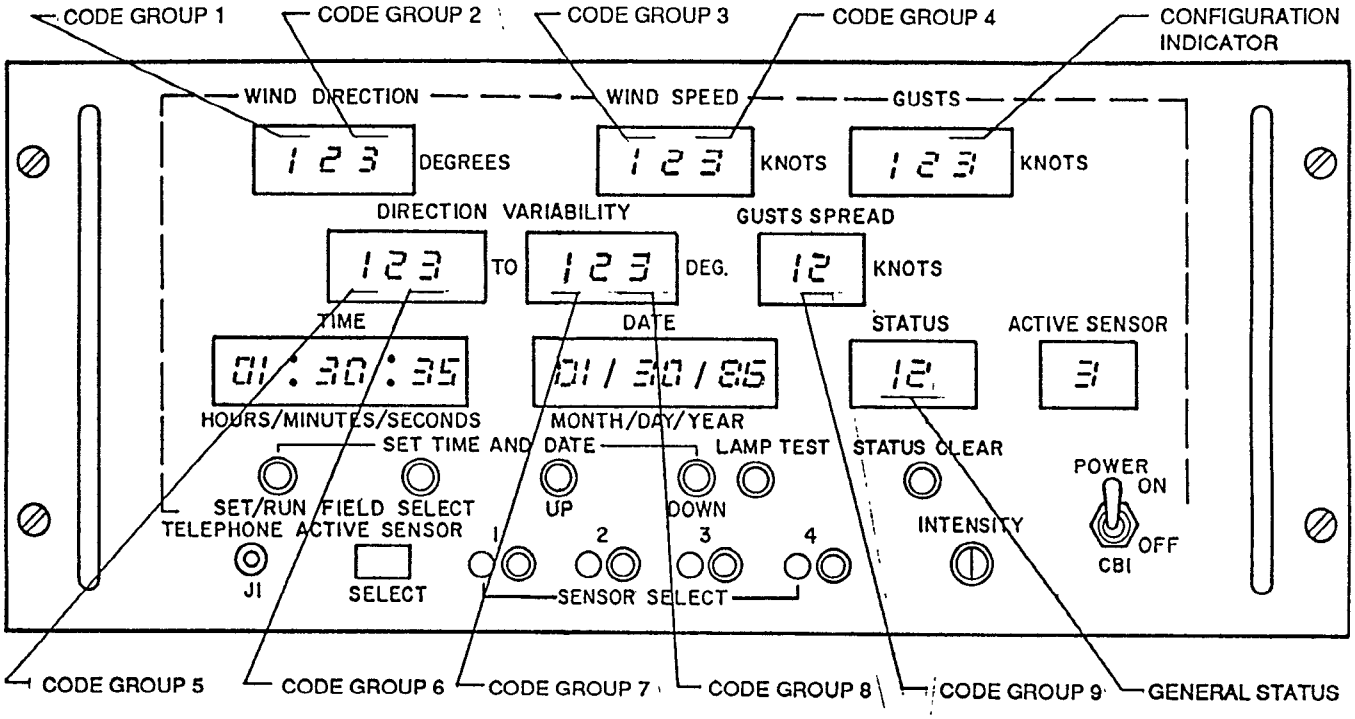


FIGURE 5-2. Error Code Groups

5-3.1 **Built-In Test Performed on All Assemblies.** The following is a description of all tests which are continuously run on all assemblies.

a. **CPU Test**. Performs a sequence of instructions with a known input and compares the results to the correct answer stored in ROM.

b. **RAM Test**. Write and read data patterns to all locations.

c. **ROM Test**. Sums contents of the ROM using 16 bits and compares results to stored 16-bit check sum.

d. **Inter-assembly Communications Interface Loop Test**. The transmitter is externally looped back to the receiver and characters are tested periodically.

5-3.2 **Built-In Test Performed on Indicator/Recorder Assemblies.** The following is a description of tests which are run on all indicator/recorder assemblies.

a. **Inter-Assembly Communications Interface Time-Out Test**. Checks that polling occurs every 5 seconds and in the proper sequence.

b. **Inter-Assembly Communications Interface CRC-16 Test**. Checks the received message using a CRC-16 test.

c. **AWDS Interface Loop Test**. The transmitter is externally looped back to the receivers and characters are checked periodically.

d. **Printer Test (Recorder Only)**. Reports the status of the printer interface for printer fault, printer off-line, and paper out conditions.

5-3.3 **Built-In Test Performed on Sensor Assemblies**. The following is a list of tests which are run on all sensor assemblies.

a. A/D test.
b. Temperature transducer test.
c. Pressure transducer test.
d. Element driver test.
e. Power supply test.
f. Counter test.

5-3.4 **Display Test.** The Display Test generates a countdown sequence that is displayed on all the LEDs at the same time. This tests all of the display circuitry. Running this test does not interfere with the other functions of the indicator. The test is initiated by pressing the RUN/SET pushbutton while the indicator is in the Status Display Mode. Pressing the RUN/SET pushbutton again will terminate the test. Exiting the Status Display Mode will also terminate the test.

Table 5-2. General Status Codes, STATUS Display-Left Digit

Display Code Number	Indicated Status
0	No Error
1	Processor PCBA fault. Failure of one or more of the following tests: (1) CPU Test, (2) ROM Test, (3) RAM Test, or (4) Inter-Assembly Communications Port Loop Test.
2	Sensor Error-Any error report from the sensor
3	Combination of codes 1 and 2
4	Loss of Master
5	Combination of codes 1 and 4
6	Combination of codes 2 and 4
7	Combination of codes 1, 2, and 4

Table 5-3. General Status Codes, STATUS Display-Right Digit

Display Code Number	Indicated Status
0	No Errors
1	Printer Error (Recorder Only)
2	Inter-Assembly Communications Error. Failure of one or more of the following tests: (1) Communications 5-second Time-Out, (2) CRC-16 Error, (3) Carrier Time-Out, and/or (4) No Sensor Response
3	Combination of codes 1 and 2
4	Recovery in Progress
5	Combination of codes 1 and 4
6	Combination of codes 2 and 4
7	Combination of codes 1, 2, and 4

Table 5-4. Status Display Mode Codes for Indicator/Recorder, Status Word WIND DIRECTION Display-Left Digit (Code Group 1)

Display Code Number	Indicated Status
0	No Errors
1	Inter-Assembly Communications Loop Test Failure
2	Inter-Assembly 5-second Communications Time-Out-Error
3	Combination of codes 1 and 2
4	Inter-Assembly Carrier Time-Out Error
5	Combination of codes 1 and 4
6	Combination of codes 2 and 4
7	Combination of codes 1, 2, and 4

Table 5-5. Status Display Mode Codes for Indicator/Recorder, Status Word WIND DIRECTION Display-Right Digit (Code Group 2)

Display Code Number	Indicated Status
0	No Errors
1	CPU Test Failed
2	ROM Test Failed
3	Combination of codes 1 and 2
4	RAM Test Failed
5	Combination of codes 1 and 3
6	Combination of codes 2 and 4
7	Combination of codes 1, 2, and 4

Table 5-6. Status Display Mode Codes for Indicator/Recorder, Status Word WIND SPEED Display-Left Digit (Code Group 3)

Display Code Number	Indicated Status
0	No Errors
1	Printer Out of Paper
2	Printer Off-Line
3	Combination of codes 1 and 2
4	Printer Fault
5	Combination of codes 1 and 4
6	Combination of codes 2 and 4
7	Combination of codes 1, 2, and 4

Table 5-7. Status Display Mode Codes for Indicator/Recorder, Status Word WIND SPEED Display-Right Digit (Code Group 4)

Display Code Number	Indicated Status
0	No Errors
1	AWDS Loop Test Failed
2	N/A, Reserved
3	N/A
4	Loss of Master
5	Combination of codes 1 and 4
6	N/A
7	N/A

Table 5-8. Status Display Mode Codes for Sensor Status Word DIRECTION VARIABILITY Left Display-Left Digit (Code Group 5)

Display Code Number	Indicated Status
0	No Errors
1	Multiple Reset Error
2	Counter Test Failed
3	Combination of codes 1 and 2
4	Inter-Assembly Loop Test Failed
5	Combination of codes 1 and 4
6	Combination of codes 2 and 4
7	Combination of codes 1, 2, and 4

Table 5-9. Status Display Mode Codes for Sensor Status Word, DIRECTION VARIABILITY Left Display-Right Digit (Code Group 6)

Display Code Number	Indicated Status
0	No Errors
1	CPU Test Failed
2	ROM Test Failed
3	Combination of codes 1 and 2
4	RAM Test Failed
5	Combination of codes 1 and 4
6	Combination of codes 2 and 4
7	Combination of codes 1, 2, and 4

Table 5-10. Status Display Mode Codes for Sensor Status Word, DIRECTION VARIABILITY Right Display-Left Digit (Code Group 7)

Display Code Number	Indicated Status
0	No Errors
1	Out of Range Error
2	Pressure Sensor Test Failed
3	Combination of codes 1 and 2
4	Power Supply Test Failed
5	Combination of codes 1 and 4
6	Combination of codes 2 and 4
7	Combination of codes 1, 2, and 4

Table 5-11. Status Display Mode Codes for Sensor Status Word, DIRECTION VARIABILITY Right Display-Right Digit (Code Group 8)

Display Code Number	Indicated Status
0	No Errors
1	A/D Test Failed
2	Element Driver Test Failed
3	Combination of codes 1 and 2
4	Temperature Sensor Test Failed
5	Combination of codes 1 and 4
6	Combination of codes 2 and 4
7	Combination of codes 1, 2, and 4

Table 5-12. Status Display Mode Codes for Sensor Status Word, GUST SPREAD Display - Right Digit (Code Group 9)

Display Code Number	Indicated Status
0	No Errors
1	Long Recovery in Process
2	No Sensor Response
3	Combination of codes 1 and 2
4	CRC 16 Error
5	Combination of codes 1 and 4
6	Combination of codes 2 and 4
7	Combination of codes 1, 2, and 4

5-4 MINIMUM PERFORMANCE TESTS.

5-4.1 **Purpose of Tests**. The performance tests are used to:

a. Verify performance of the wind measuring set.

b. Locate faulty assemblies or parts in the individual assemblies.

c. Locate faulty system communications/cables.

d. Verify performance of the wind measuring set after repair is accomplished.

5-4.2 **Assembly Performance Test**. Paragraphs 5-4.2.1, 5-4.2.2 and 5-4.2.3 provide test procedures which should be used for acceptance testing of the indicator, recorder and sensor assemblies, respectively. Sensor performance is verified indirectly by monitoring wind data displayed on the indicator(s) and recorder(s) with a zero-wing or no-wind condition being induced on the sensor under tests. If correct information (given in table 5-15) is not displayed on an individual indicator or recorder, verify that the indicator or recorder used to monitor the sensor under test is set to select the sensor under test by making the sensor under test the active sensor or by selecting the sensor using the MOMENTARY SELECT feature (indicator(s) only) before suspecting the local indicator or recorder or the sensor as being faulty.

NOTE

The MOMENTARY SELECT feature times-out after 60 seconds and the displayed data reverts back to the active sensor.

NOTE

A status code of 04 is normal during the first 24 hours after turning power on at any unit.

NOTE

The sensor performance test should be conducted AFTER cleaning the sensor elements.

5-4.2.1 **Indicator Test**. Perform the test procedures of table 5-13 to test the performance of the indicator.

Table 5-13. Indicator Performance Test

Step	Procedure	Normal Indication
1	Ensure that POWER switch is ON.	
2	Turn INTENSITY control full counter-clockwise	
3	Observe front panel displays while adjusting INTENSITY control from full counterclockwise to full clockwise position.	INTENSITY control adjusts brightness from completely off to maximum brightness (full cw).
4	Depress and hold the LAMP TEST push-button while observing the 7-segment displays.	All 7-segment displays display a number 8.
5	Depress and hold the LAMP TEST push-button while adjusting the INTENSITY control to desired display brightness.	
6	Verify that CONFIGURATION switch is in proper position (MASTER, BACKUP, or REGULAR).	
7	Observe the wind data displayed on the WIND DIRECTION, WIND SPEED, GUSTS, DIRECTION VARIABILITY, and GUSTS SPREAD displays. Compare with wind data displayed on another indicator or recorder.	Wind data displayed corresponds to data displayed on other indicators or recorders.
8	Observe the ACTIVE SENSOR display.	The ACTIVE SENSOR display displays the number of the active sensor selected by master indicator.
9	Observe the STATUS display.	No error code is displayed other than 04 during the first 24 hours.
10	Depress SENSOR SELECT pushbuttons 1-4 in sequence.	SENSOR SELECT indicators 1-4 light when the corresponding pushbutton is depressed.
11	Observe the TIME display.	Correct time is displayed and display updates once each second.
12	Use headsets to verify that voice communication is possible between all assemblies.	Voice communication achieved between all assemblies.

5-4.2.2 **Recorder Test**. Perform the test procedures of table 5-14 to test the performance of the recorder.

Table 5-14. Recorder Performance Test

Step	Procedure	Normal Indication
1	Ensure that POWER switch is ON.	
2	Turn INTENSITY control full counter-clockwise.	
3	Observe front panel displays while adjusting INTENSITY control from full counterclockwise to full clockwise position.	INTENSITY control adjusts brightness from completely off (full ccw) to maximum brightness (full cw).
4	Depress and hold the LAMP TEST push-button while observing the 7-segment displays.	All 7-segment displays display a number 8.
5	Depress and hold the LAMP TEST push-button while adjusting the INTENSITY control to desired display brightness.	
6	Verify that CONFIGURATION switch is in proper position (MASTER, BACKUP, or REGULAR).	
7	Observe the wind data displayed on the WIND DIRECTION, WIND SPEED, GUSTS, DIRECTION VARIABILITY, and GUSTS SPREAD displays. Compare with wind indicators.	Wind data displayed corresponds to data displayed on other indicators or recorders.
8	Observe the ACTIVE SENSOR display.	The ACTIVE SENSOR display displays the number of the active sensor selected by master indicator.
9	Observe the STATUS display.	No error code is displayed other than 04 during the first 24 hours of operation.
10	Depress DISPLAY SELECT pushbuttons 1-4 in sequence.	DISPLAY SELECT buttons indicators 1-4 light when the corresponding pushbutton is depressed.
11	Observe the TIME display.	Correct time is displayed and display updates once each second.
12	Observe the printer printout at the recorder.	The time and date on the printout matches the displayed time and date. Columns on printout should be aligned.

Table 5-14. Recorder Performance Test - CONT

Step	Procedure	Normal Indication
13	At the master indicator, select a different active sensor while someone monitors the audible alarm at the recorder.	The recorder audible alarm sounds when the active sensor is changed.
14	Depress the ALARM RESET pushbutton to silence the alarm.	
15	Use headsets to verify that voice communication is possible between all assemblies.	Voice communication achieved between all assemblies.

5-4.2.3 **Sensor Test.** Perform the test procedure of table 5-15 to test the performance of the sensor.

NOTE

Perform the test AFTER cleaning the sensor elements per paragraph 5-8.1.

WARNING - THE SPIKES ON TOP OF THE SENSOR HAVE SHARP POINTS. COVER SPIKES WITH SUITABLE PROTECTIVE MATERIAL. HANDLE SENSOR ASSEMBLY WITH CARE. FAILURE TO DO SO CAN CAUSE INJURY.

Table 5-15. Sensor Performance Test

Step	Procedure	Normal Indication
1	Ensure that the sensor power switch is ON.	
2	Ensure that the indicator or recorder used to monitor the sensor has the sensor under test selected.	
3	Ensure that all relevant error codes are clear (Code Groups 1, 2, 5-8 = 0, Code Group 9 = 0 or 1).	
4	Cover the sensor anemometer section with suitable material to block all air flow to the elements.	

Table 5-15. Sensor Performance Test - CONT

Step	Procedure	Normal Indication
5	Monitor the DIRECTION and SPEED displays on the indicator or recorder. Normal readings should be acquired by the indicator or recorder in a maximum of 2 minutes.	Direction = 000 if Speed = 000 Direction = 1-360, Speed = 001
6	Remove cover used in step 4 from the sensor.	

5-5 SYSTEM TROUBLESHOOTING.

Paragraph 5-5.1 provides procedures for isolating faults in the wind measuring set to a defective subassembly (i.e., microprocessor PCBA, display PCBA, etc). Reference is made to paragraphs 5-5.2 and 5-5.3 which provide additional information for troubleshooting network problems or power supply problems, respectively. When a defective subassembly is isolated, it should be returned to the depot for off-equipment repair. Include a detailed description of the trouble symptoms with the defective subassembly including displayed error code(s).

5-5.1 **System Troubleshooting Procedures**. Table 5-16 provides on-equipment fault isolation procedures for the wind measuring set. The trouble symptoms (observed on one or more indicators and/or recorders) are based on conditions observed during normal operation or during execution of the minimum performance test of paragraph 5-4.2. The probable cause of trouble and corresponding remedy are arranged in the mostly likely order of occurrence. If the corrective action procedures of table 5-16 do not result in correction of the problem, special maintenance is required (see Section II).

When the STATUS display flashes and displays a general status code, press the STATUS CLEAR pushbutton. This will cause the STATUS display to stop flashing and will clear the error code if the fault condition is no longer present. If the fault remains, the STATUS display will continue to display the general status code. Detailed status code information may be obtained by using an alternate display mode known as the Status Display Mode. Enter the Status Display Mode by depressing the STATUS CLEAR pushbutton while holding the LAMP TEST pushbutton depressed. The WIND DIRECTION and WIND SPEED displays will provide a status code for the assembly (indicator and recorder). The DIRECTION VARIABILITY and GUST SPREAD displays will provide a status code for each sensor when selected using the four select switches on the front panel. Reference should then be made to tables 5-17 through 5-25, as applicable, to locate the malfunction.

Table 5-16. On-Equipment Fault Isolation of Wind Measuring Set

Trouble Symptom	Probable Cause	Remedy
All indicator/ recorder front panel displays blank. LAMP TEST pushbutton depressed; none of the displays on the indicator or recorder displays a number 8.	Primary power not provided to assembly.	Ensure that assembly is connected to primary power source, and that associated circuit breaker is on.
	POWER switch not turned on.	Verify that POWER switch is ON.
	INTENSITY control turned down.	Verify that INTENSITY control is not turned fully CCW.
	Faulty power supply circuits.	Refer to paragraph 5-5.3 to troubleshoot power supply circuits.
	Faulty display PCBA.	Replace display PCBA in affected indicator/recorder assembly.
Indicator/recorder displays illuminate but adjusting intensity control does not vary display brightness.	a. Faulty display circuits.	a. Replace display PCBA in affected indicator/recorder assembly.
	b. Faulty intensity control potentiometer.	b. Replace intensity control potentiometer in affected indicator/recorder assembly.
Time display does not maintain correct time after power down.	a. Battery jumper not installed.	a. Install battery jumper.
	b. Battery discharged.	b. Replace microprocessor PCBA in affected indicator/recorder assembly.
Time display does not update.	a. Faulty micro-processor circuits.	a. Replace microprocessor PCBA in affected indicator/recorder assembly.
Active sensor cannot be changed.	a. Configuration switch not in MASTER position.	a. Verify that CONFIGURATION switch is in the MASTER position at master indicator.
	b. Faulty CONFIGURATION switch assembly.	b. Replace CONFIGURATION switch assembly.
	c. Faulty Display circuits.	c. Replace display PCBA in appropriate indicator/recorder.
General status code isnot 00.	Proceed to tables 5-17 through 5-25 as applicable.	

Table 5-17. Indicator/Recorder Fault Isolation Based on Error Codes Displayed on WIND DIRECTION Display - Left Digit (Code Group 1)

Code	Indication	Probable Cause	Remedy
0	No errors		

NOTE: The indicator/recorder must be in master or backup mode to display odd numbered codes in this table.

1	Inter-assembly communication loop test failure.	Faulty inter-assembly interface circuit	Replace microprocessor PCBA in indicator/recorder displaying error code.
2	Inter-assembly 5-second communication time-out cannot receive input.	Faulty inter-assembly interface circuit	Replace microprocessor PCBA in indicator/recorder displaying error code.
3	Combination of inter-assembly communication loop and inter-assembly 5-second communication timeout test failure.	a. Faulty inter-assembly interface circuit	a. Replace microprocessor PCBA in indicator/recorder displaying error code.
		b. Wiring problem	b. Check inter-assembly wiring.
4	Inter-assembly carrier timeout CRC error.	a. Faulty inter-assembly interface circuit.	a. Replace microprocessor PCBA in indicator/recorder displaying error.
		b. Network problem involving bad inter-assembly wiring, a bad sensor, or a bad master	b. Refer to paragraph 5-5.2 to troubleshoot the network.
5	Combination of inter-assembly communication loop test failure and inter-assembly carrier timeout error.	Faulty inter-assembly interface circuit	Replace microprocessor PCBA in indicator/recorder displaying error code.

Table 5-17. Indicator/Recorder Fault Isolation Based on Error Codes Displayed on WIND DIRECTION Display - Left Digit (Code Group 1) - CONT

Code	Indication	Probable Cause	Remedy
6	Combination of inter-assembly 5-second communication timeout test failure and inter-assembly carrier timeout error.	a. Faulty inter-assembly interface circuit	a. Replace microprocessor PCBA in indicator/recorder displaying error code.
		b. Network problem involving bad inter-assembly wiring, a bad sensor, or a bad master	b. Refer to paragraph 5-5.2 to troubleshoot the network.
7	Combination of inter-assembly communication loop failure inter-assembly 5-second communication timeout error, and inter-assembly carrier timeout error.	a. Faulty inter-assembly interface circuit	a. Replace microprocessor PCBA in test indicator/recorder
		b. Network problem involving bad inter-assembly wiring, a bad sensor, or a bad master	b. Refer to paragraph 5-5.2 to troubleshoot the network.

Table 5-18. Indicator/Recorder Fault Isolation Based on Error Codes Displayed on WIND DIRECTION Display - Right Digit (Code Group 2)

Code	Indication	Probable Cause	Remedy
0	No errors		
1	CPU test failed	Faulty microprocessor circuit	Replace microprocessor PCBA in indicator/recorder displaying error code.
2	ROM test failed	Faulty EPROM, RAM, or microprocessor circuit	Replace microprocessor PCBA in indicator/recorder displaying error code.
3	Combination of CPU and RAM failures	Faulty EPROM or microprocessor circuit	Replace microprocessor PCBA in indicator/recorder displaying error code.
4	RAM test failure	Faulty RAM, EPROM, or microprocessor circuit	Replace microprocessor PCBA in indicator/recorder displaying error code.
5	Combination of CPU and RAM failures	Faulty RAM or microprocessor circuit	Replace microprocessor PCBA in indicator/recorder displaying error code.
6	Combination of ROM and RAM test failures	Faulty RAM or EPROM circuit	Replace microprocessor PCBA in indicator/recorder displaying error code.
7	Combination of CPU, ROM, and RAM test failures	Faulty RAM, EPROM, or CPU circuit	Replace microprocessor PCBA in indicator/recorder displaying error code.

Table 5-19. Recorder Fault Isolation Based on Error Codes Displayed on WIND SPEED Display - Left Digit (Code Group 3)

Code	Indication	Probable Cause	Remedy
0	No errors		
1	Printer paper out	a. Printer out of paper	a. Replenish paper supply.
		b. Printer cable disconnected	b. Reconnect printer cable.
2	Printer off-line	Printer deselected at control switch on printer	a. Depress printer select switch.
			b. Turn "on" printer power switch.
3	Combination of printer paper out and printer off-line	a. Printer out of paper	a. Replenish paper supply.
		b. Printer deselected at control switch	b. Turn "on" printer power switch.
4	Printer fault	a. Printer cable disconnected	a. Reconnect printer cable.
		b. Faulty printer port	b. Replace display PCBA.
		c. Faulty printer	c. Replace the printer.
5	Combination of printer paper out and printer fault	a. Printer cable disconnected	a. Reconnect printer cable.
		b. Faulty printer port	b. Replace display PCBA.
		c. Faulty printer	c. Replace the printer.
6	Combination of printer off-line and printer fault	a. Printer cable disconnected	a. Reconnect printer cable.
		b. Faulty printer port	b. Replace display PCBA.
		c. Faulty printer	c. Replace the printer.
7	Combination of printer paper out, printer off-line and printer fault	a. Printer deselected at control switch on printer	a. Turn "on" printer power switch.
		b. Faulty printer port	b. Replace display PCBA.
		c. Faulty printer	c. Replace the printer.

Table 5-20. Indicator/Recorder Fault Isolation Based on Error Codes Displayed on WIND SPEED Display - Right Digit (Code Group 4)

Code	Indication	Probable Cause	Remedy
0	No errors		
1	AWDS loop test failure	Faulty AWDS interface circuit	a. Replace microprocessor PCBA in indicator/recorder displaying error code. b. Replace interconnect PCBA in indicator/recorder displaying error code.
2	N/A		
3	N/A		
4	Loss of master	Does not include any specific hardware fault	Will normally be set during bench test if master mode is not tested.
5	Combination of AWDS loop test failure and loss of master	Faulty AWDS interface circuit	Replace microprocessor PCBA in indicator/recorder displaying error code.
6	N/A		
7	N/A		

Table 5-21. Sensor Fault Isolation Based on Error Codes Displayed on DIRECTION VARIABILITY Left Display - Left Digit (Code Group 5)

Code	Indication	Probable Cause	Remedy
0	No errors		
1	Multiple reset error	Faulty microprocessor PCBA	Replace sensor control assembly
2	Counter test failed	Faulty counter IC U11	Replace sensor control assembly
3	Combination of multiple reset error and counter test failed	Faulty counter U11	Replace sensor control assembly
4	Inter-assembly loop test failed	Faulty network or faulty modem circuit	If isolated to single sensor, replace power supply
5	Combination of multiple reset error and inter-assembly loop test failure	Faulty microprocessor PCBA	Replace sensor control assembly
6	Combination of counter test error and inter-assembly loop test failure	Faulty counter IC U11	Replace sensor control assembly
7	Combination of multiple reset error, counter test failure, and inter-assembly loop test failure	Faulty microprocessor PCBA	Replace sensor control assembly

Table 5-22. Sensor Fault Isolation Based on Error Codes Displayed on DIRECTION VARIABILITY Left Display - Right Digit (Code Group 6)

Code	Indication	Probable Cause	Remedy
0	No errors		
1	CPU test failed	Faulty microprocessor PCBA	Replace sensor control assembly on unit sending error code
2	ROM test failed	Faulty EPROM, RAM, or microprocessor circuit	Replace sensor control assembly on unit sending error code
3	Combination of CPU and RAM test failures	Faulty EPROM or microprocessor circuit	Replace sensor control assembly on unit sending error code
4	RAM test failed	Faulty RAM, EPROM, or microprocessor circuit	Replace sensor control assembly on unit sending error code
5	Combination of CPU and RAM test failures	Faulty RAM or microprocessor circuit	Replace sensor control assembly on unit sending error code
6	Combination of ROM and RAM test failures	Faulty RAM or CPU circuit	Replace sensor control assembly on unit sending error code
7	Combination of CPU, ROM, and RAM test failures	Faulty RAM, EPROM, or CPU circuits	Replace sensor control assembly on unit sending error code

Table 5-23. Sensor Fault Isolation Based on Error Codes Displayed on DIRECTION VARIABILITY Right Display - Left Digit (Code Group 7)

Code	Indication	Probable Cause	Remedy
0	No errors		
1	Out-of-range error	Sensor senses winds outside of calculated range (100 knots for standard sensor, 150 knots for ruggedized sensor)	If no high winds have been observed, replace sensor control assembly on unit sending error code
2	Pressure sensor test failed	Faulty pressure sensor	Replace sensor control assembly on unit sending error code
3	Combination out-of-range error and pressure sensor test failure	Faulty pressure sensor PCBA (A10)	Replace sensor control assembly on unit sending error code
4	Power supply failure	Faulty power supply assembly	Replace power supply assembly
5	Combination of out-of-range error and power supply test failure	Faulty power supply assembly	Replace power supply assembly
6	Combination of pressure sensor test failure and power supply test failure	Faulty power supply assembly	Replace power supply assembly
7	Combination of out-of-range error, pressure sensor test failure and power supply test failure	Faulty power supply assembly	Replace power supply

Table 5-24. Sensor Fault Isolation Based on Error Codes Displayed on DIRECTION VARIABILITY Right Display - Right Digit (Code Group 8)

Code	Indication	Probable Cause	Remedy
0	No errors		
1	A/D test failure	Faulty A/D circuit	Replace control assembly on unit sending error code
2	Element driver test failure	a. Faulty element driver circuit	a. Replace control assembly on unit sending error code
		b. Faulty sensor element	b. Replace control assembly on unit sending error code
3	Combination of A/D test failure and element driver test failures	a. Faulty A/D circuit	a. Replace control assembly on unit sending error code
		b. Faulty element driver circuit	b. Replace control assembly on unit sending error code
4	Temperature sensor test failure	a. Faulty temperature circuit	a. Replace control assembly on unit sending error code
		b. Faulty temperature sensor	b. Replace control assembly on unit sending error code
5	Combination of A/D test and temper-ature test failures	a. Faulty A/D circuit	a. Replace control assembly on unit sending error code
		b. Faulty temperature circuit	b. Replace control assembly on unit sending error code
		c. Faulty temperature sensor	c. Replace control assembly on unit sending error code
6	Combination of element driver test and active sensor test failures	a. Faulty element driver circuit or temperature circuit	a. Replace control assembly on unit sending error code
		b. Faulty sensor element	b. Replace control assembly on unit sending error code

Table 5-24. Sensor Fault Isolation Based on Error Codes Displayed on DIRECTION VARIABILITY Right Display - Right Digit (Code Group 8) - CONT

Code	Indication	Probable Cause	Remedy
7	Combination of A/D test, element driver test, and temperature sensor test failures	a. Faulty A/D circuit	a. Replace control assembly on unit sending error code
		b. Faulty element driver circuit	b. Replace control assembly on unit sending error code
		c. Faulty sensor element	c. Replace control assembly on unit sending error code
		d. Faulty temperature circuit	d. Replace control assembly on unit sending error code
		e. Faulty temperature sensor	e. Replace control assembly on unit sending error code

Table 5-25. Sensor Fault Isolation Based on Error Codes Displayed on GUST SPREAD Display (Code Group 9)

Code	Indication	Probable Cause	Remedy
0	No errors		
1	Long recovery in process	Assembly displaying code or any sensor unit off-line presently or any time during the past 24 hours	Return all sensors to on-line status. This status code will clear after 24 hours of continuous on-line operation.
2	No sensor response	a. Loss of power to sensor if error displayed on multiple units	a. Restore power to sensor.
		b. Network failure to isolated sensor	b. Check communication link to sensor
		c. Faulty sensor power assembly	c. Replace power supply assembly
		d. Faulty sensor control assembly	d. Replace sensor control assembly
3	Combination of long recovery in progress and no response errors	a. Loss of power to sensor if error displayed on multiple units	a. Restore power to sensor
		b. Network failure to isolated sensor	b. Check communication link to sensor
		c. Faulty sensor power assembly	c. Replace power supply assembly
		d. Faulty sensor control assembly	d. Replace sensor control assembly
4	CRC 16 error	a. Sensor communication failure if failure involves only one sensor	a. Replace sensor control assembly. If failure continues, replace power supply assembly.
		b. Network communication problem if failure involves more than one sensor	b. Repair inter-assembly communication network

Table 5-25. Sensor Fault Isolation Based on Error Codes Displayed on GUST SPREAD Display (Code Group 9) - CONT

Code	Indication	Probable Cause	Remedy
5	Combination of long recovery in process and CRC 16 errors	a. Sensor communication failure if failure involves only one sensor	a. Replace sensor control assembly. If failure continues, replace sensor power supply assembly.
		b. Network communication problem if failure involves more than one sensor	b. Repair inter-assembly communication network
6	Combination of no sensor response and long recovery in process	a. Loss of power to sensor if error displayed on multiple units	a. Restore power to sensor
		b. Network failure to isolated sensor	b. Check communication link to sensor
		c. Faulty sensor power assembly	c. Replace power supply assembly
		d. Faulty sensor control assembly	d. Replace sensor control assembly
7	Combination of 1, 2, and 4	a. Loss of power to sensor if error displayed on multiple units	a. Restore power to sensor
		b. Network failure to isolated sensor	b. Check communication link to sensor
		c. Faulty sensor power assembly	c. Replace power supply assembly
		d. Faulty sensor control assembly	d. Replace sensor control assembly

5.5-2 **Troubleshooting Network Problems**. Perform the following procedure to troubleshoot network problems.

5-5.2.1 **Equipment Required But Not Supplied**. The following test equipment is required to troubleshoot network problems:

a. Oscilloscope.

b. Bell 202-type modem, Universal Data System model 202T, or equivalent.

c. Protocol Analyzer, Hewlett-Packard model 4951B or equivalent.

5-5.2.2 **Procedure.** Perform the following procedure to localize a fault on the inter-assembly communications channel including the inter-assembly wiring and the inter-assembly interface circuits on the sensor, indicator, and recorder.

a. Disconnect the cable from the INTER-ASSEMBLY COMMUNICATIONS connector on all indicators and recorders.

b. Connect an oscilloscope across the J3-A and J3-B pins of the INTER-ASSEMBLY COMMUNICATIONS connector (J3) on the master indicator/recorder.

c. Refer to paragraph 2-9.1.1.3, step c to connect the Carrier On jumper on the microprocessor PCBA of the master indicator/recorder.

d. Verify that a 0 dBm sinewave (corresponding to 2.2V peak-to-peak) is displayed on the oscilloscope.

   (1) If sinewave is not displayed, replace the microprocessor PCBA in the master indicator/recorder.

   (2) If sinewave displayed on master indicator/recorder, continue with step e.

e. Disconnect the oscilloscope from the INTER-ASSEMBLY COMMUNICATIONS connector and reconnect the inter-assembly wiring.

f. Verify that the active sensor is responding to the poll from the master indicator/recorder by checking for a minimum -35 dBm (40 mV peak-to-peak) signal level on the E1 and E2 pins on the EM1 filter PCBA at each indicator/recorder location.

   (1) If signal is not observed at any indicator/recorder location, use the Bell-202 modem and the protocol analyzer to determine whether the trouble is in the polled sensor or in the inter-assembly wiring. If the inter-assembly wiring is suspected of being faulty, use the protocol analyzer to transmit a test pattern on the inter-assembly wiring and monitor the signal at the remote indicators/recorders.

   (2) If signal is not observed at one or more, but not all, indicators/recorders, use the Bell-202 type modem and the protocol analyzer to isolate the problem to an individual indicator or recorder.

5-5.3 **Troubleshooting Power Supply Problems**. Paragraphs 5-5.3.1 and 5-5.3.2 provide procedures for troubleshooting indicator/recorder and sensor power supply problems, respectively. When troubleshooting, refer to the appropriate power distribution diagram in the circuit diagrams manual.

5-5.3.1 **Indicator/Recorder Power Supply/Distribution Circuits.** (See FIGURE 23 of T.O. 31M1-2FMQ13-3) Troubleshoot the indicator/recorder power supply/distribution circuits as indicated in Table 5-26.

The indicator/recorder uses five power supplies to provide power for all of its functions. These voltages are derived by linear voltage regulators and rectifiers from a power transformer. Primary power is supplied to the transformer via an EMI filter, a circuit breaker/switch assembly, and the interconnect board. The interconnect board contains the jumpers used to configure the transformers dual primaries for 115 or 230 volt operation.

All of the power supply outputs can be monitored at test points on the microprocessor PCBA and the display PCBA. Normally, the first step in troubleshooting a power supply problem would be to check these testpoints with a DVM. The chassis must be in a place where there is sufficient space to remove the top cover and gain access to the chassis interior. There must also be access to line voltage for power. Other connections such as AWDS, communications, and printer are not necessary for this test. Remove the top cover by turning the fasteners 1/4 turn counter-clockwise until they release. Place the negative lead of the DVM on the ground (TP4) testpoint and use the positive lead to check the following power supply test points.

Supply One	Test Point	Limits
Analog +5 volts	microprocessor PCBA TP1	4.75v - 5.25v
Digital +5 volts	microprocessor PCBA TP5	4.75v - 5.25v
VLED (See note)	display PCBA TP10 (VLED)	5.0v - 5.5v
+12 volts	microprocessor PCBA TP3	11.4v - 12.6v
-12 volts	microprocessor PCBA TP16	-12.6v - -11.4v

NOTE

TP10 of the display PCBA is the last testpoint on the top right as viewed from the **front.** This test point is accessible from the back of the display PCBA. This voltage can be measured without removing the display PCBA from the chassis.

If any of these voltages are out of limits check the transformer secondary voltages which are accessed through the plastic cover over the transformer on the right hand side of the chassis. The voltages should test as follows:

31 VAC A to B (LUG 6 to 8) 25.0-34.7 VAC

31 VAC A to CT (LUG 6 to 7) 12.5-17.4 VAC

10 VAC A to C (LUG 9 to 10) 8.0-11.6 VAC

Use the voltage reading from the test points and transformer secondaries with table 5-26 to pinpoint power supply problems to an LRU.

Table 5-26. Troubleshooting Power Supply Problems

Trouble Symptom	Probable Cause	Remedy
All test points read 0.0V. All transformer secondaries read 0.0V.	a. CB1 off	a. Turn CB1 on
	b. No primary power applied	b. Verify that primary power is applied
	c. E32 misjumpered	c. Verify E32 jumper configuration
Analog +5V (TP1) output reads high or low. All other test points normal. Transformer secondary voltages are normal.	Faulty supply components on microprocessor PCBA	Replace microprocessor PCBA
Digital +5V (TP5) output reads high or low. All other test points normal. Transformer secondary voltages are normal.	Faulty voltage regulator (U2) on back panel of chassis	Replace voltage regulator U2
VLED (display board) (TP10) reads high or low. All other test points normal. Transformer secondary voltages are normal.	Faulty voltage regulator (U1) on back panel of chassis	Replace voltage regulator U1
+12V or -12V output (TP2 or TP16) reads high or low. All other power supply test points normal.	Faulty power supply circuits on microprocessor PCBA	Replace microprocessor PCBA
A+5 (TP1) reads low or 0V. 10VAC transformer secondary voltage reads low. Other test points normal.	a. Excess load on A+5 power supply due to faulty microprocessor PCBA circuits	a. Replace microprocessor PCBA
	b. Excess load on +5, D+5, or VLED power supplies due to faulty display PCBA circuits	b. Replace display PCBA

Table 5-26. Troubleshooting Power Supply Problems - CONT

Trouble Symptom	Probable Cause	Remedy
+12V and -12V (TP3 and TP16) outputs read low or 0V. 31VAC transformer secondary reads low. Other test points normal.	Excess load on +12V or -12V power supplies due to faulty microprocessor circuits.	Replace microprocessor PCBA.

5-5.3.2. **Sensor Power Supply/Distribution Circuits.** (See FIGURE 9 of T.O. 31M1-2FMQ13-3.) The Sensor Power Supply Assembly is comprised of two PCBAs combined into one assembly. The two PCBAs are referred to as the Sensor Power Assembly - Front and the Sensor Power Assembly - Back. The front PCBA is the one that is accessible when the Sensor Power Supply Assembly is installed in the sensor chassis. The sensor used four power supplies; +15, +12, +5, and -15. The +15, +5, and -15 supplies are produced from linear regulators located on the power front PCBA. The +12 supply is produced from a switching regulator located on the power back PCBA.

Power to the primary side of the transformer is supplied through the circuit breaker (CB1) to the EMI Sensor Terminal PCBA. From there primary power is routed to the front power supply PCBA through the over voltage protection and out to the power transformer through connector J2 on the power front PCBA. The secondary side of the transformer provides power through the same J2 connector to the power front PCBA. Jumpers on the power front PCBA configure the transformers dual primaries for 115 or 230 VAC operation.

All the power supply outputs can be monitored on the power front PCBA at the points indicated in the following list. Check these test points using a DVM set to measure DC voltage with the negative lead connected to ground testpoint (TP7).

Supply	Test Point	Limits
+5 volts	TP4	4.75V - 5.25
+15 volts	TP9	14.25V - 15.75
-15 volts	TP5	-14.25V - - 15.75
+12 volts	Contact Point E1	11.00 - 13.00

If any of these voltages are out of limits check the transformer secondary voltages. Set the DVM to measure AC voltage and measure the voltage between transformer pins 7 and 8 and pins 7 and 9. These readings should range from 25.0 to 31.0 VAC.

Use the voltage readings from the test points with table 5-27 to pinpoint power supply problems to an LRU.

Table 5-27. Troubleshooting Sensor Power Supply Problems

Trouble Symptom	Probable Cause	Remedy
All test points read 0.0 volts	a. CB1 off	a. Turn CB1 ON
	b. No primary power applied	b. Verify that primary power is applied
	c. 115/230 jumpers not set correctly	c. Verify E15 jumper configuration
	d. Primary power not reaching power front PCBA	d. Faulty CB1 or faulty wiring or faulty EMI PCBA
+5 volt (TP4) reads low or high. All other test points normal.	Faulty voltage regulator U4.	Replace power supply assembly.
+12 volt (E1) reads low or high. All other test points normal.	Faulty voltage regulator on power back PCBA.	Replace power supply assembly.
+15 volt (TP9) reads low or high. All other test points normal.	Faulty voltage regulator U5.	Replace power supply assembly.
-15 volt (TP5) reads low or high. All other test points normal.	Faulty voltage regulator U6.	Replace power supply assembly.
Secondary voltage 0.0 volts or very low. Primary voltage confirmed to the power front PCBA and in range.	Faulty transformer.	Replace transformer assembly.

5-6 DISASSEMBLY.

5-6.1 **Indicator Assembly**. Referring to FIGURE 5-3, Sheet 1, disassemble the indicator assembly as follows:

a. Disconnect AC power at its source.

b. Remove AC power, communications, AWDS, and ground connections from rear of the chassis.

c. Support the chassis while removing four large slotted screws (111) from outside edges of faceplate near handles and carefully withdraw chassis from rack.

d. Place chassis on bench top. Loosen ten quarter-turn fasteners (4) securing top cover (1) by turning each one quarter-turn counterclockwise with a number two Phillips screwdriver.

e. Lift the cover (1) off of chassis, taking care not to damage the EMI gasket (2). Set the cover aside.

CAUTION

Before performing the following steps, personnel should be effectively static protected. Further disassembly should take place at a static-free work station. Failure to do so can damage equipment.

f. Referring to FIGURE 5-3, sheet 2, remove microprocessor PCBA (30) by inserting fingers into the two large holes and pulling straight upward. Place the microprocessor PCBA in a static-free bag.

g. Disconnect the display PCBA (26) connector by pressing down and outward on each of the two ears on J2 of the interconnect PCBA (31), gently pulling the ribbon cable connector free.

h. Remove nine panhead screws (27) from the front panel with a number two Phillips screwdriver. Set screws, washers and lockwashers aside.

i. Carefully withdraw the display PCBA (26) from the inside of the chassis and lift out. Place the display PCBA aside in a static-free bag.

j. Disconnect all sixteen faston type connectors from the interconnect PCBA (31) with a suitable pair of longhandled pliers.

k. Disconnect transformer plug from J5 by depressing tabs on each side and pulling straight upwards.

l. Remove four screws (32 and 34) from the interconnect PCBA (two of these go through connector J1 and two go through the board alone, one at the left front and one at the right front) with a number one Phillips screwdriver.

m. Remove the interconnect PCBA (31) from chassis and place in a static-free bag.

n. Remove the transformer shield panel (35) by removing four screws (36) with a number two Phillips screwdriver and withdrawing panel from chassis.

o. Remove the microprocessor PCBA support assembly (46) from chassis by removing two Phillips panhead screws (52) from the rear of the chassis and three Phillips flathead screws from the bottom of the chassis. Then withdraw the support assembly from inside the chassis.

p. Using a 5/16" nutdriver, remove the nut (43) from the diode bridge (38A) beneath and to the left of the transformer (38). Retrieve the nut (43), washer (44) and lockwasher (45) and set aside.

q. Remove the transformer assembly (38) by removing two Phillips panhead screws (41) from rear of chassis while supporting the transformer, then withdraw the transformer assembly from chassis. Retrieve all hardware and set aside.

r. Referring to FIGURE 5-3, sheet 1 remove the front display panel (5) by first removing the INTENSITY control knob (11) with a 0.050" Hex key, then the four flathead Phillips screws (6) with a number two Phillips screwdriver. Remove the front display panel while taking care not to scratch or damage the red filter lens.

s. Remove the INTENSITY adjust potentiometer (10) by removing its locknut (10A) with a 5/16" nutdriver.

t. Referring to FIGURE 5-3, sheet 3 remove the circuit breaker assembly (54) as follows:

(1) Remove the CB1 locknut (54A) with a 1/2" nutdriver or wrench.

(2) Remove the noise filter (54D) with a 5/16" nutdriver or wrench.

(3) Remove rear panel connector J2 (54E) with a number one Phillips screwdriver. Be careful to catch and save all loose hardware.

u. Remove the communications cable assembly by removing nut (93A) from telephone jack J1 (93) with a 1/2" nutdriver or wrench, and removing the communications jack J3 (93C) with a number one Phillips screwdriver. Retain all loose hardware.

v. Remove the configuration switch (92) by first placing it in the center position (backup) and then removing the locknut (92A) with a 5/16" nutdriver or wrench.

w. Referring to FIGURE 5-3, sheet 3 the VLED (U1) and Digital +5 (U2) regulators (73 and 87) may each now be removed as follows:

(1) Remove the plastic cover (68 and 82) by pulling by hand.

(2) Remove the regulator screws and unplug the regulator (73 and 87) from the socket.

(3) Remove the socket (64 and 78) by removing the single flathead Phillips screw (74, 88) that remains.

5-6.2 **Partial Disassembly of Indicator**. A partial disassembly of the indicator assembly may be accomplished by performing the following referenced steps of paragraph 5-6.1.

Major Parts	Refer to Paragraph 5-6.1, Steps
Microprocessor PCBA	a-f
Interconnect PCBA	a-g, k-m
Display PCBA	a-i
Transformer assembly	a-f, k, n-q
LED regulator	a-f, w
Digital regulator	a-f, w
Circuit breaker assembly	a-f, k, n-r, t
Configuration switch	a-f, j, v
Communications cable assembly	a-n, r, u

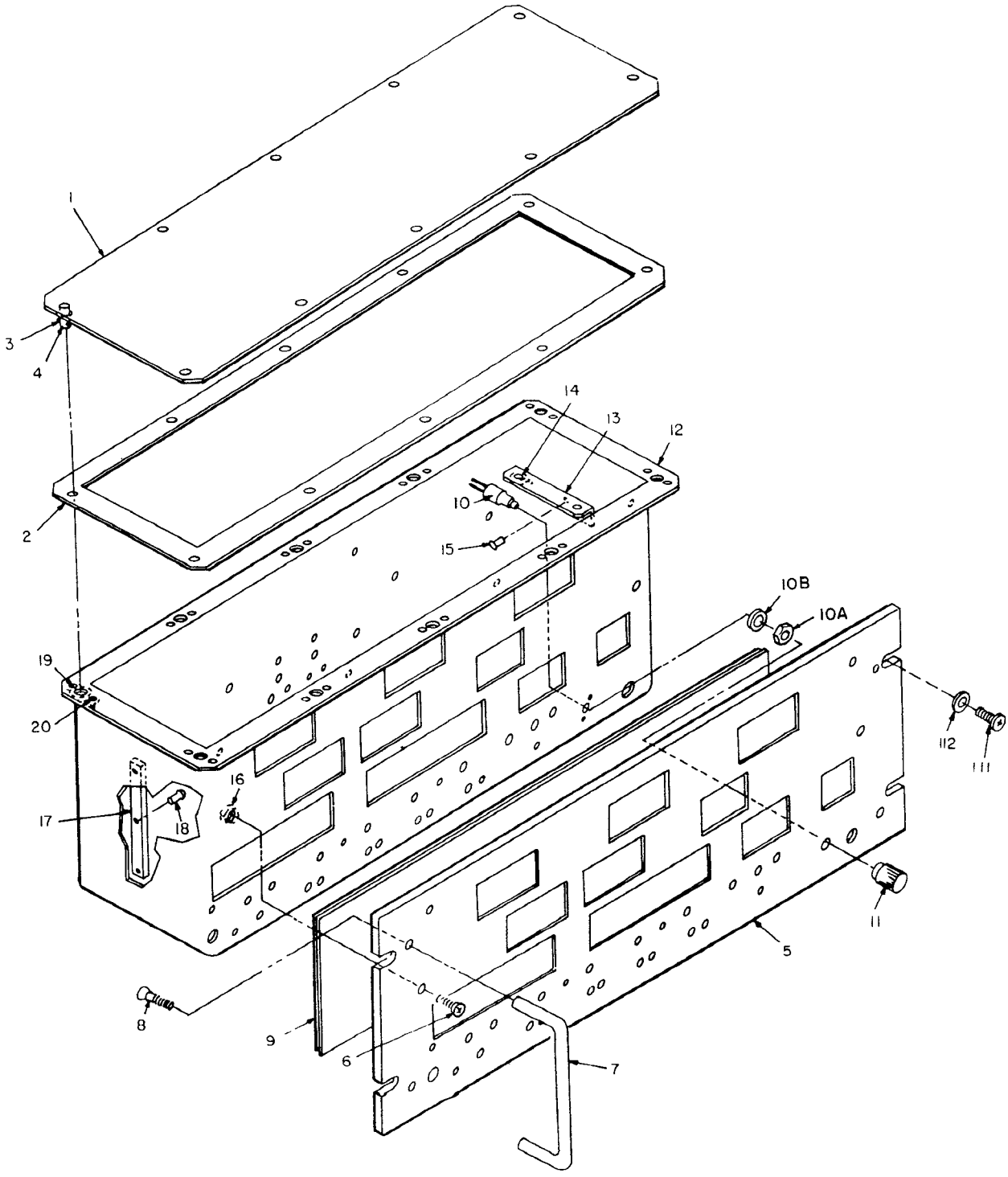


FIGURE 5-3. Digital Display Indicator Assembly (Sheet 1 of 3)

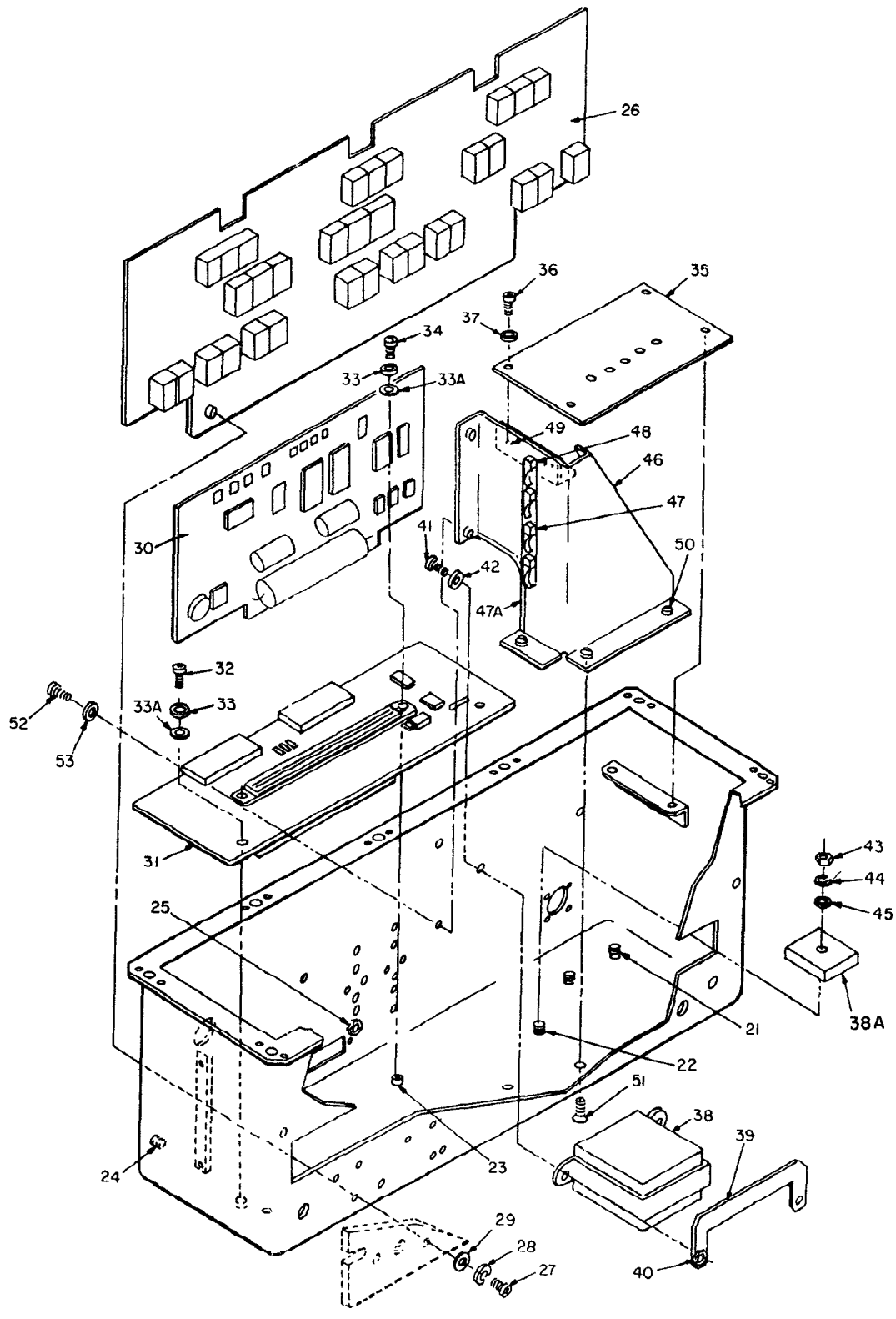


FIGURE 5-3. Digital Display Indicator Assembly (Sheet 2 of 3)

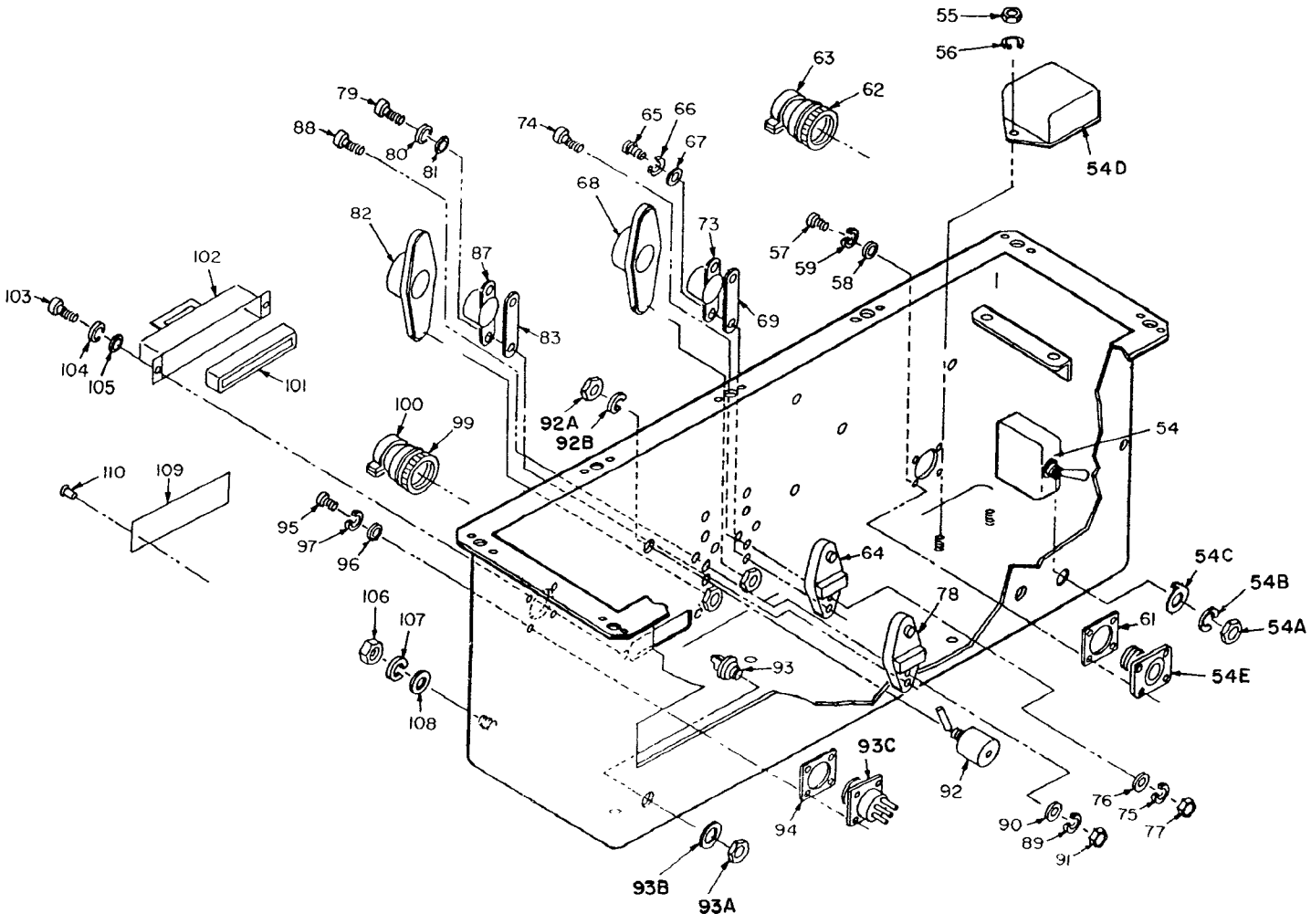


FIGURE 5-3. Digital Display Indicator Assembly (Sheet 3 of 3)

5-6.3 **Recorder Assembly**. Referring to FIGURE 5-4, sheet 1, disassemble the recorder assembly as follows:

a. Disconnect AC power at its source.

b. Remove AC power, communications, AWDS, and ground connections from rear of the chassis.

c. Support the chassis while removing four large slotted screws (120) from outside edges of faceplate near handles and carefully withdraw chassis from rack.

d. Place chassis on bench top. Loosen ten quarter-turn fasteners (4) securing top cover (1) by turning each one quarter-turn counterclockwise with a number two Phillips screwdriver.

e. Lift the cover (1) off of chassis, taking care not to damage the EMI gasket (2). Set the cover aside.

CAUTION

Before performing the following steps, personnel should be effectively static protected. Further disassembly should take place at a static-free work station. Failure to do so can damage equipment.

f. Refering to FIGURE 5-4, sheet 2, remove microprocessor PCBA (30) by inserting fingers into the two large holes and pulling straight upward. Place the microprocessor PCBA in a a static-free bag.

g. Disconnect the display PCBA (26) connector by pressing down and outward on each of the two ears on J2 of the interconnect PCBA (31), gently pulling the ribbon cable connector free.

h. Remove nine panhead screws (27) from the front panel with a number two Phillips screwdriver. Set screws, washers and lockwashers aside.

i. Carefully withdraw the display PCBA (26) from the inside of the chassis and lift out. Place the display PCBA aside in a static-free bag.

j. Disconnect all eighteen faston type connectors from the interconnect PCBA (31) with a suitable pair of longhandled pliers.

k. Disconnect transformer plug from J5 by depressing tabs on each side and pulling straight upwards.

l. Remove four screws (32 and 34) from the interconnect PCBA (two of these go through connector J1 and two go through the board alone, one at the left front and one at the right front) with a number one Phillips screwdriver.

m. Remove the interconnect PCBA (31) from chassis and place in a static-free bag.

n. Remove the transformer shield panel (35) by removing four screws (36) with a number two Phillips screwdriver and withdrawing panel from chassis.

o. Remove the microprocessor PCBA support assembly (46) from chassis by removing two Phillips panhead screws (52) the rear of the chassis and three Phillips flathead screws from the bottom of the chassis. Then withdraw the support assembly from inside the chassis.

p. Using a 5/16" nutdriver, remove the nut (43) from the diode bridge (38A) beneath and to the left of the transformer (38). Retrieve the nut (43), washer (44) and lockwasher (45) and set aside.

q. Remove the transformer assembly (38) by removing two Phillips panhead screws (41) from rear of chassis while supporting the transformer, then withdraw the transformer assembly from chassis. Retrieve all hardware and set aside.

r. Referring to FIGURE 5-4, sheet 1 remove the front display panel (5) by first removing the INTENSITY control knob (11) with a 0.050" Hex key, then the four flathead Phillips screws (6) with a number two Phillips screwdriver. Remove the front display panel while taking care not to scratch or damage the red filter lens.

s. Remove the INTENSITY adjust potentiometer (10) by removing its locknut (10A) with a 5/16" nutdriver.

t. Referring to FIGURE 5-4, sheet 3 remove the circuit breaker assembly (54) as follows:

(1) Remove the CB1 locknut (54A) with a 1/2" nutdriver or wrench.

(2) Remove the noise filter (54D) with a 5/16" nutdriver or wrench.

(3) Remove rear panel connector J2 (54E) with a number one Phillips screwdriver. Be careful to catch and save all loose hardware.

u. Remove the communications cable assembly by removing the locknut (97A) from telephone jack J1 (97) with a 1/2" nutdriver or wrench, and removing the communications jack J3 (97C) with a number one Phillips screwdriver. Retain all loose hardware.

v. Remove the configuration switch (96) by first placing it in the center position (backup) and then removing the locknut (96A) with a 5/16" nutdriver or wrench.

w. Referring to FIGURE 5-4, sheet 3 the VLED (U1) and Digital +5 (U2) regulators (73 and 87) may each now be removed as follows:

(1) Remove the snap-on plastic cover (72 and 86) by pulling by hand.

(2) Remove the regulator screws and unplug the regulator (77 and 91) from the socket.

(3) Remove the socket (68 and 82) by removing the single flathead Phillips screw (69 and 83) that remains.

x. Remove AC power jack J4 (63) by removing the four attaching screws with a number one Phillips screwdriver.

5-6.4 **Partial Disassembly of Recorder**. A partial disassembly of the indicator assembly may be accomplished by performing the following referenced steps of paragraph 5-6.3.

Major Parts	Refer to Paragraph 5-6.1, Steps
Microprocessor PCBA	a-f
Interconnect PCBA	a-g, k-m
Display PCBA	a-i
Transformer assembly	a-f, k, n-q
LED regulator	a-f, w
Digital regulator	a-f, w
Circuit breaker assembly	a-f, k, n-r, t
Configuration switch	a-f, h, i, v
Communications cable assembly	a-n, r, u

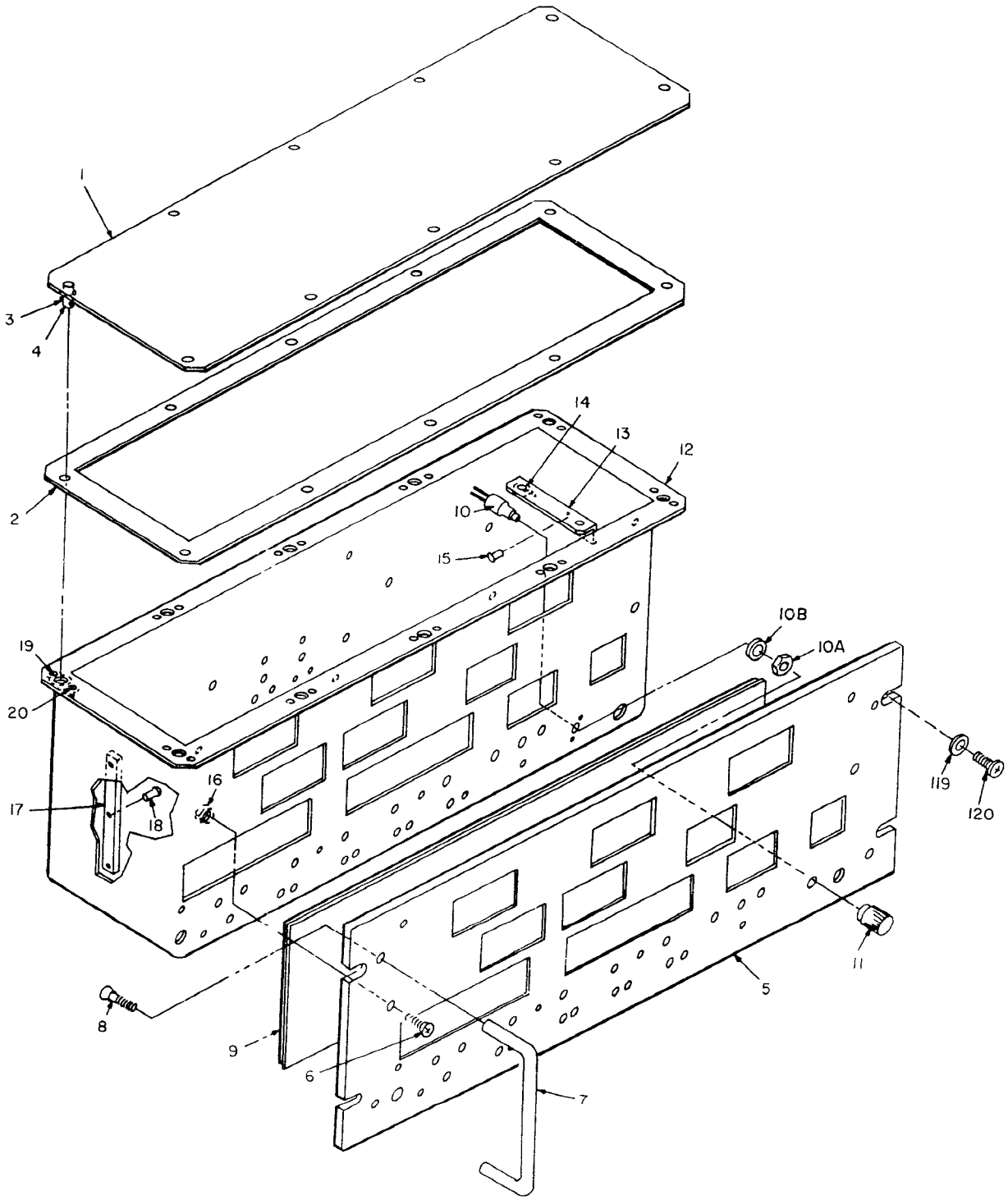


FIGURE 5-4. Recorder Assembly (Sheet 1 of 3)

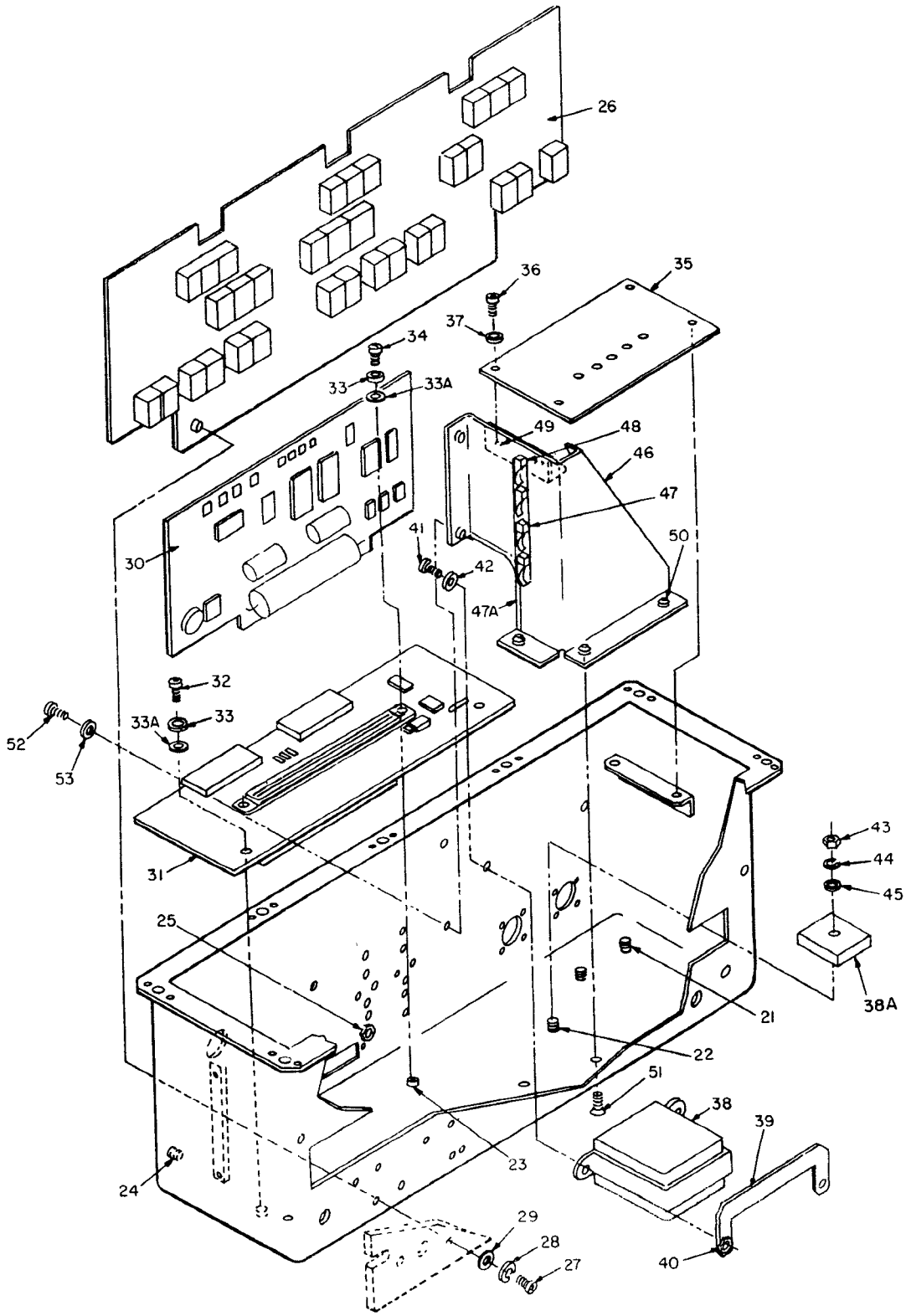


FIGURE 5-4. Recorder Assembly (Sheet 2 of 3)

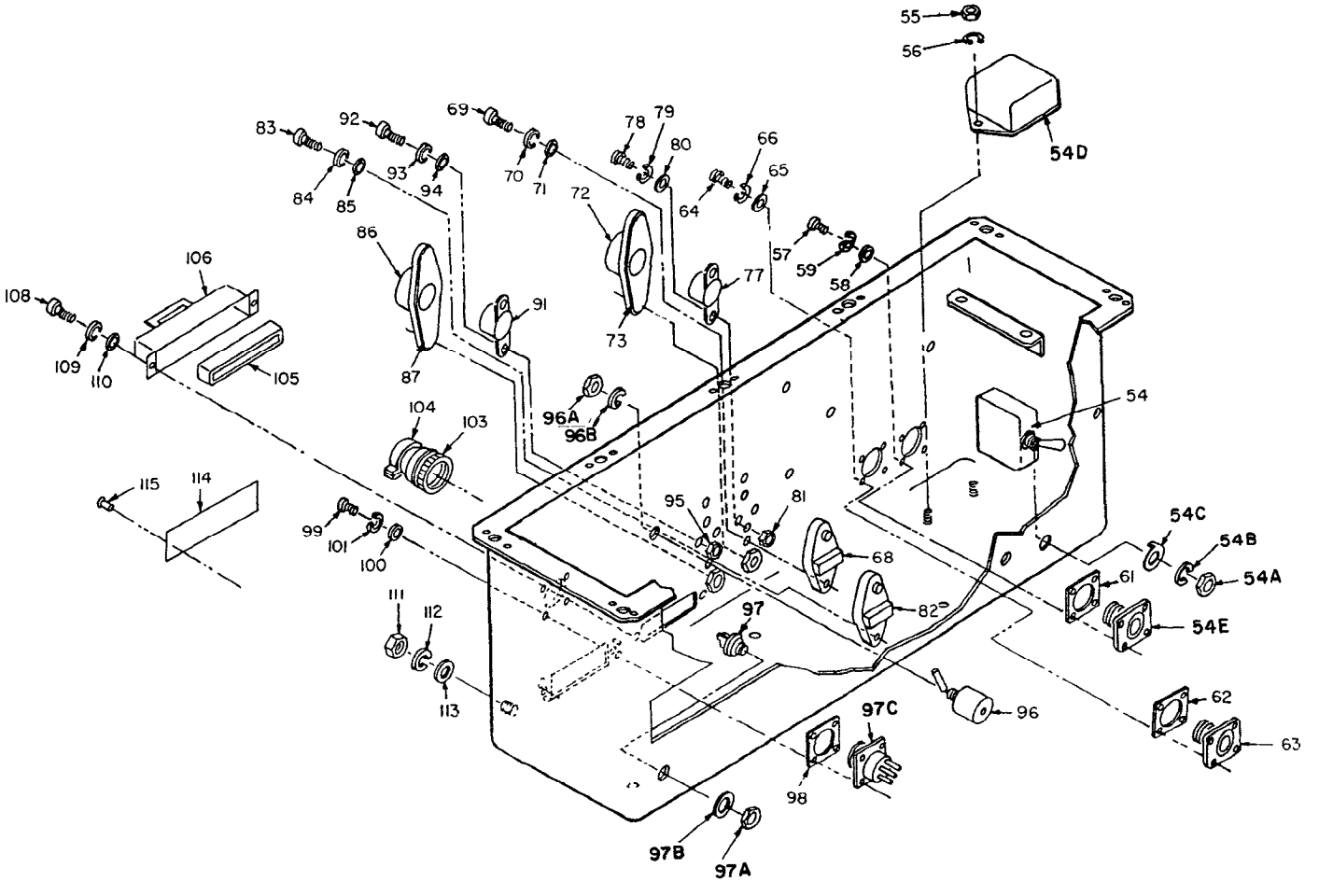


FIGURE 5-4. Recorder Assembly (Sheet 3 of 3)

5-6.5 **Sensor Assembly**. Referring to FIGURE 5-5, disassemble the sensor assemblies as follows:

a. Disconnect AC power at its source.

b. Open cover by turning cover screws (13) counterclockwise by hand until they release from chassis. (These are captive screws and won't fall out).

c. Remove TB-1 safety shield (47) by removing two Phillips-head screws (49) with a number one Phillips screwdriver.

d. Remove all external power and communications connections from TB-1 using a common screwdriver.

e. Loosen U-bolt clamp nuts (15) with a 7/16" nutdriver or wrench and lift sensor assembly (1) from pole.

CAUTION

Further disassembly of the sensor should take place at a static-free work station by static protected personnel. Failure to do so can damage equipment.

f. Unplug 24 pin connector from J1 on power supply assembly (19) by depressing tabs on each side and pulling straight upward.

g. Referring to FIGURE 5-6 loosen four common screws (3) under sensor head with a 1/8 common driver. (These are captive screws and will not fall out.)

h. Withdraw control assembly (2) from chassis.

i. Referring to FIGURE 5-5 disconnect transformer plug from J2 on power supply assembly (19) by depressing the tabs on each side and pulling straight upward.

j. Disconnect the faston type terminal from E12 on power supply assembly (19) by pulling straight upward.

k. Remove the faston type terminals from E1, E2, E4, and E5 of the EMI PCBA (35).

l. Remove the EMI sensor terminal assembly (35) by disconnecting any remaining wires and removing the two Phillips-head screws (44) that secure it to the back panel

m. Remove six screws (27 and 28) from the power assembly (19) (two go through the heat sink into the bottom of the chassis, and four go through the back power board into the back) with a number two Phillips screwdriver. Pull wire out from around bead (57).

n. Withdraw the power assembly from the sensor chassis. Retain all loose hardware.

o. Remove the transformer assembly (52) by removing four Phillips-head screws (53) that hold it to the back panel and withdrawing it from chassis. Save all loose hardware.

p. Remove the circuit breaker assembly (56) by removing the locknut from CB-1 (56) with a 1/2" wrench or nutdriver. Withdraw the circuit breaker assembly from the inside of the chassis.

q. Pull wire out from around bead (57).

5-6.6. **Partial Disassembly of Sensor Assembly.** A partial disassembly of the sensor assemblies may be accomplished by the following referenced steps of paragraph 5-6.5.

Major Parts	Refer to Paragraph 5-6.5, Steps
Control assembly	a, b, g-h
Power assembly	a-d, g, i-n
Transformer assembly	a, b, o
Circuit breaker assembly	a-d, j-l, p, q

5-6.7. REASSEMBLY. Reassembly for each item can be achieved by following the disassembly instructions in reverse order. Replace both upper and lower O-rings, PN MS9068-044, prior to reassembling the sensor assembly.

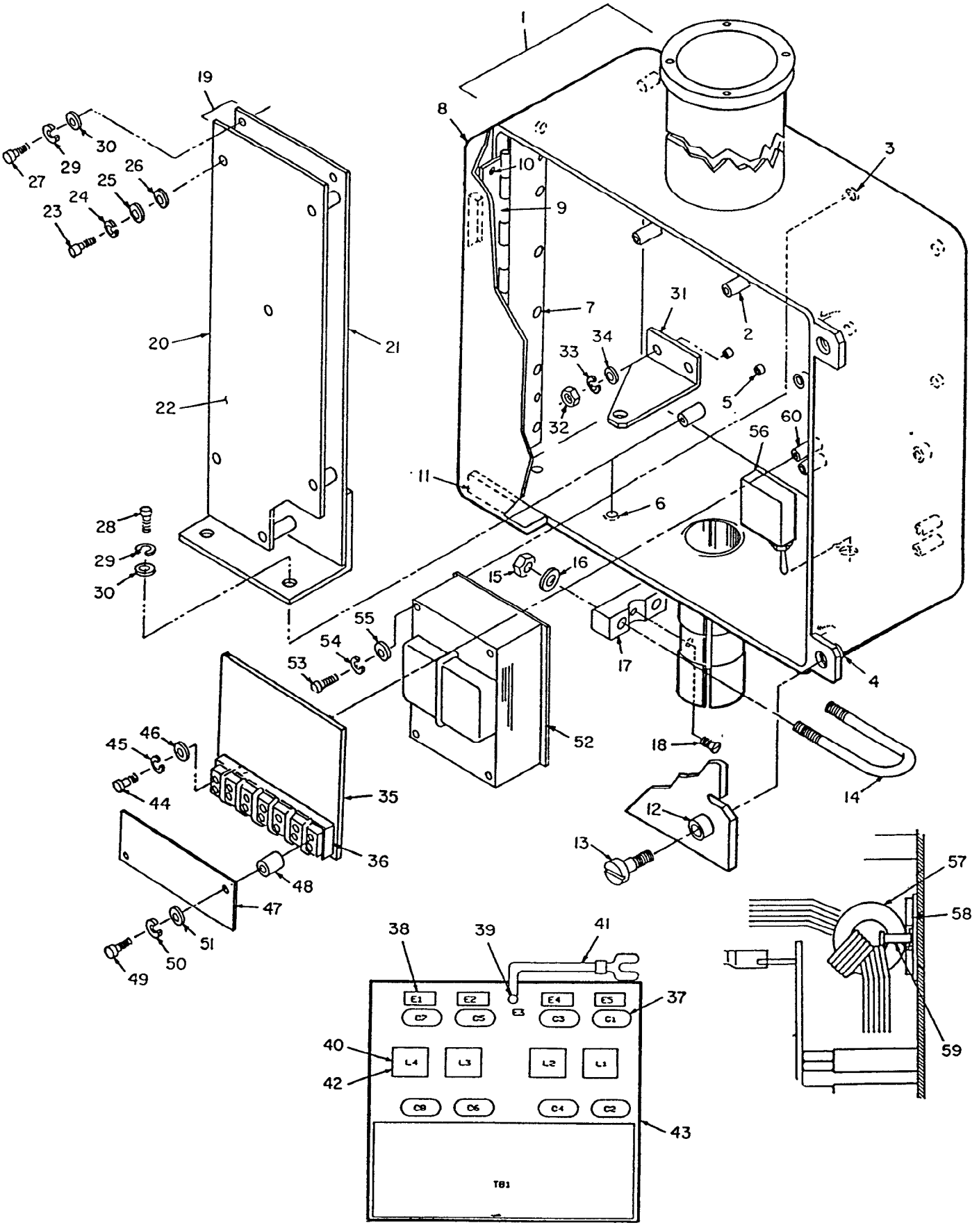


FIGURE 5-5. Power Assembly

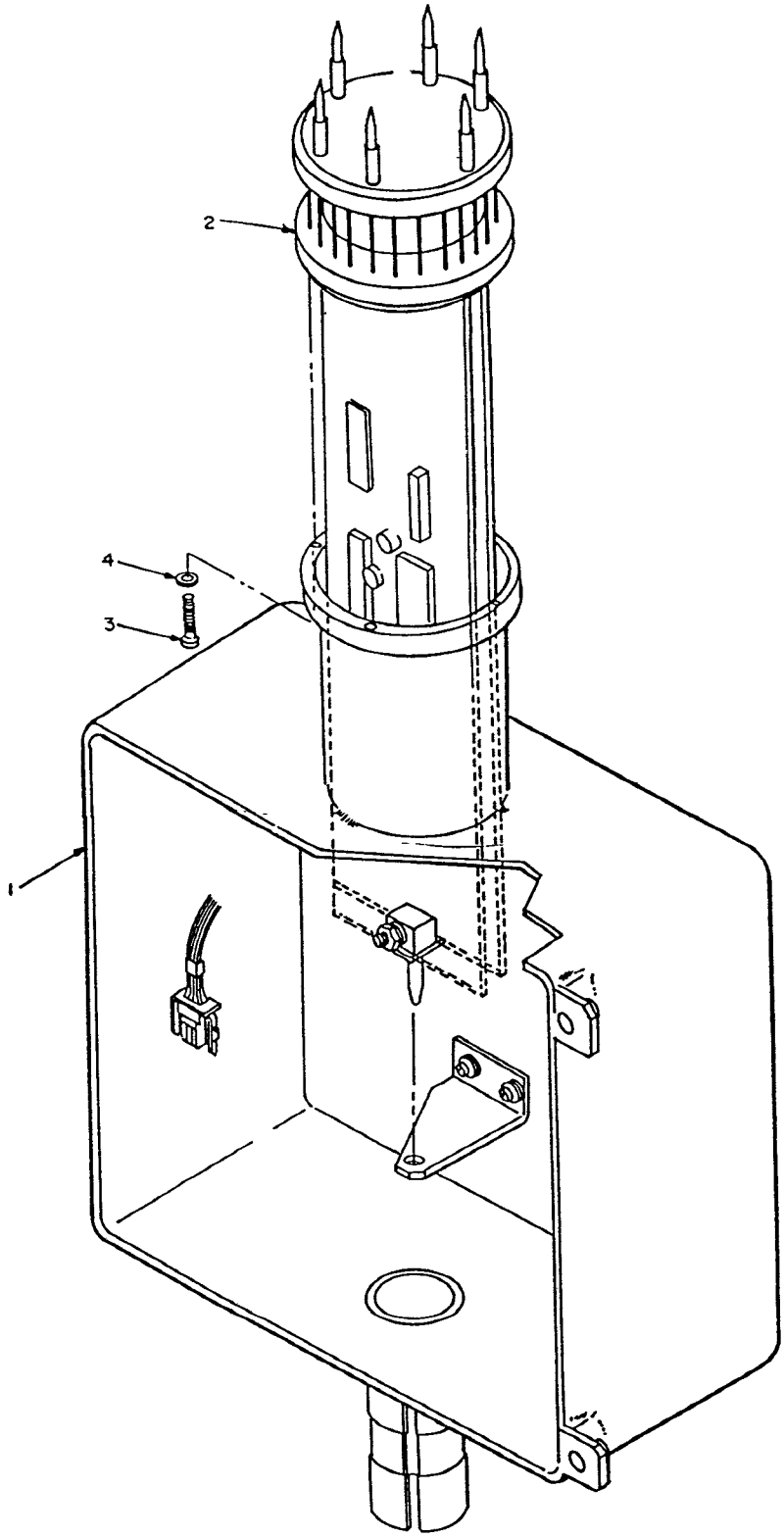


FIGURE 5-6. Sensor Assembly

5-7 PREVENTIVE MAINTENANCE.

5-7.1 **General.** Complete preventive maintenance is the performance of routine services (paragraph 5-7.3) and preventive maintenance checks and services (paragraph 5-7.4) to insure that the equipment is available and ready for its mission.

5-7.2 **Equipment Required But Not Supplied.** The following is a list of tools and materials required to perform preventive maintenance:

a. Tool Kit TK-105/G.
b. Isopropyl Alcohol.
c. Lint-free cloths.
d. Small soft-bristle brush (#1 Stencil Brush).
e. Safety glasses.

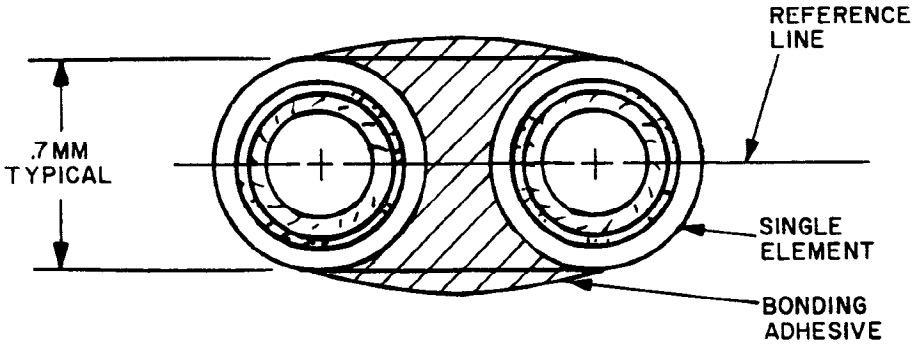
5-7.3 **Routine Service.** Routine services are checks and observations performed by the operator at all times. The operator should perform the following routines as necessary:

a. Cleaning (paragraph 5-8).
b. Dusting.
c. Washing.
d. Check for cut or frayed cables.
e. Check for dented, bent, or broken components.
f. Check to see that items not in use are properly stored.
g. Check for rusting.

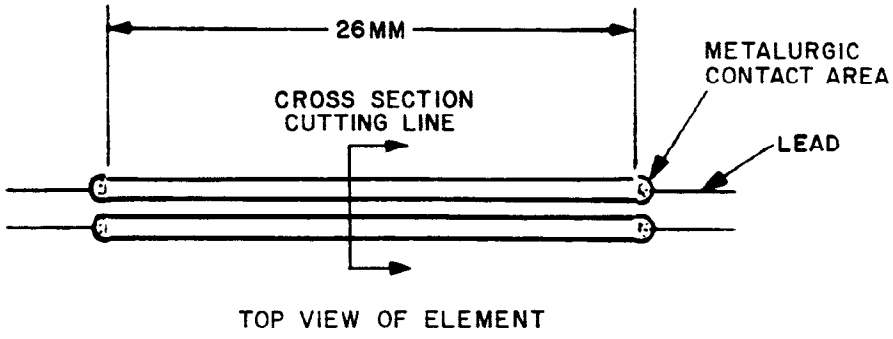
5-7.4 **Preventive Maintenance Checks and Services (PMCS).** To insure that the wind measuring system is always ready for operation, it must be inspected systematically so that defects may be discovered and corrected before they result in serious damage or failure. The necessary preventive maintenance checks and services to be performed are listed in table 5-28 through 5-30.

5-7.4.1 **Inspection of the Sensor** The sensor should be inspected regularly to be certain that the sensing elements and the cage bars are free of dirt and debris and have not been damaged by any wildlife or other external force. The alignment of the elements and the bars of the cage affect the performance of the wind sensor. Misalignment of the elements or cage bars requires replacement of the control assembly. No re-alignment should be attempted in the field. Visual inspection of the alignment of the cage bars and sensing elements should be performed every 28 days.

FIGURE 5-7 shows an exploded cross section view and a top view of the sensing elements. This figure shows that the element pair forms an oval. The element pair is installed with top and bottom of the broad sides of the cross-section parallel to the flow of the wind. A line through the broad dimension of the element pair should be parallel to the horizontal surfaces of the sensor cage. FIGURE 5-8 shows the element pair as viewed end-on and looking through the element support tube. A line projected through the long axis of the cross section of the element pair (reference line) should be parallel to the horizontal surfaces of the sensor cage. These figures are intended to show the proper orientation of the elements. The small size of the elements makes the determination of precise alignment difficult. Any control assembly with elements that are grossly misaligned should be replaced.



(a) EXPLODED CROSS SECTION



(b) TOP VIEW OF ELEMENT

FIGURE 5-7. Detail View of Elements;
a) Exploded Cross Section, b) Top View

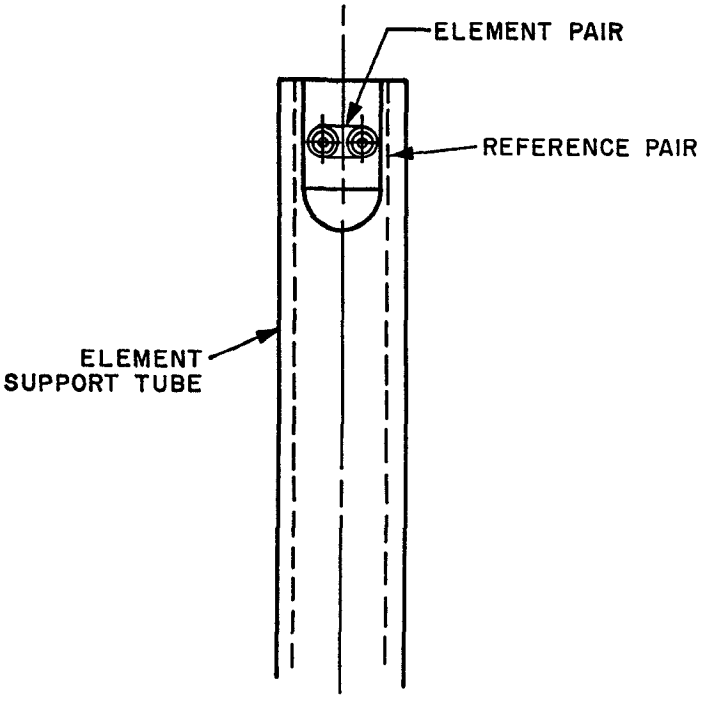


FIGURE 5-8. End-on View of Elements Mounted in Sensor.

The cage bars can be cleaned with lint-free cloth dampened with water. The elements can be cleaned with isopropyl alcohol and a small brush. (See paragraph 5-8 for cleaning instructions.)

Table 5-28. AN/FMQ-13(V) Wind Measuring Set
Preventive Maintenance Checks and Services

Interval	Item to be Inspected Wind Measuring Set	Procedure
84-Day	Inter-assembly wiring and connectors	Inspect plugs and connectors for damage and cleanliness. Insure that wires are properly connected to receptacles. Tighten all connections. Inspect cable wires for damaged connectors or damaged insulation.
84-Day	Assembly mounting	Inspect that all assemblies are securely mounted. Tighten all attached hardware.
28-Day	System Check	While performing system check, check for error message on each indicator and recorder (see paragraph 5-4).
28-Day	Operation	While operating the system, be alert for any abnormal performance or condition.
84-Day	Publications	Check to see that all publications are complete, serviceable, and current.
84-Day	Spare Parts	Check all spare parts for general condition and method of storage. There should be no evidence of over stockage, and all shortages must be on valid requisition.
56-Day	Corrosion Control	Check all surfaces for evidence of fungus. Remove rust and corrosion and spotpaint all bare spots.
28-Day	Switches and Controls	Check that all switches and controls work smoothly, and securely, and do not bind.
28-Day	External Surfaces	Remove dust, dirt, and moisture from equipment surfaces.
84-Day	Hardware	Check for loose or missing hardware.

Table 5-29. Recorder RO-588
Preventive Maintenance Checks and Services

Interval	Item to be Inspected Recorder Assembly	Procedure
28-Day	Switches and Controls	Check that all switches and controls work smoothly, and securely, and do not bind.
28-Day	External Surfaces	Remove dust, dirt, and moisture from equipment surfaces.
84-Day	Hardware	Check for loose or missing hardware.
84-Day	Printer	Remove lint and dust from the printer paper tray. Use brush to remove lint and dust from inside the printer in front of the platen.

Table 5-30. Wind Sensors ML-660 & ML-660A
Preventive Maintenance Checks and Services

Interval	Item to be Inspected Sensor Assembly	Procedure
28-Day	External Surfaces	Remove dust, dirt, and moisture from equipment surfaces.
84-Day	Hardware	Check for loose or missing hardware.
28-Day	Anemometer	Inspect and clean cage and elements. Clean elements with No. 1 stencil brush. Perform sensor acceptance test after cleaning.

5-8. CLEANING

Inspect all exposed surfaces of all equipment comprising the wind measuring system. These surfaces should be free of dust, dirt, grease, and fungus. Clean the wind measuring system as follows:

a. Remove dust and loose dirt with a clean, soft cloth. If necessary, moisten the cloth or brush with a mild soap and water. After surface is cleaned, wipe dry with a clean cloth.

CAUTION

Use only Isopropyl Alcohol for cleaning the sensor elements. Use of other solvents may damage the elements.

b. Remove grease, fungus, and ground-in dirt from the outer case; use a cloth dampened (not wet) with cleaning solvent.

c. Remove dust or dirt from the connectors with a brush.

WARNING

COMPRESSED AIR IS DANGEROUS AND CAN CAUSE SERIOUS BODILY HARM. USE PROTECTIVE EYE COVERING SUCH AS SAFETY GOGGLES. IT CAN ALSO CAUSE MECHANICAL DAMAGE TO THE EQUIPMENT. DO NOT USE COMPRESSED AIR TO DRY PARTS WHERE CLEANING COMPOUND HAS BEEN USED.

d. Use dry compressed air, not to exceed 15 pounds per square inch, to blow dust and dirt from inaccessible places of equipment.

5-8.1. **Cleaning the Sensor Elements.** Perform the following procedure to clean the sensor elements.

WARNING

REMOVE POWER FROM THE SENSOR BEFORE ATTEMPTING TO CLEAN THE ELEMENTS. FAILURE TO REMOVE POWER MAY CAUSE INJURY TO PERSONNEL AND/OR DAMAGE EQUIPMENT.

THE SPIKES ON TOP OF THE SENSOR HAVE SHARP POINTS. COVER SPIKES WITH SUITABLE PROTECTIVE MATERIAL. HANDLE SENSOR ASSEMBLY WITH CARE. FAILURE TO DO SO CAN CAUSE INJURY.

THE FOLLOWING CLEANING PROCEDURE MAY INVOLVE SPRAYING ISOPROPYL ALCOHOL. USE PROTECTIVE EYE COVERING SUCH AS SAFETY GOGGLES WHEN CLEANING THE SENSOR ELEMENTS. DO NOT SPRAY ALCOHOL NEAR EXPOSED FLAME. FAILURE TO DO SO CAN CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT.

CAUTION

Allow sensor element 25-30 minute cooling period prior to cleaning. Failure to do so can damage equipment.

a. The sensor elements can be cleaned while the sensor is mounted on the mast with the power turned OFF, if weather conditions permit. The assembly can also be cleaned by removing the unit from the mast and performing the cleaning process in an enclosed work area.

WARNING

COMPRESSED AIR IS DANGEROUS AND CAN CAUSE SERIOUS BODILY HARM. USE PROTECTIVE EYE COVERING SUCH AS SAFETY GOGGLES WHEN CLEANING THE SENSOR ELEMENTS. IT CAN ALSO CAUSE MECHANICAL DAMAGE TO THE EQUIPMENT. DO NOT USE COMPRESSED AIR TO DRY PARTS WHERE CLEANING COMPOUNDS HAS BEEN USED.

b. First try to blow dust and dirt from the elements with short blasts of aerosol duster (PN MS-222N or equivalent). If elements require further cleaning continue to next paragraph.

CAUTION

Use only Isopropyl Alcohol to clean the elements. Use of other types of cleaning fluids may damage the elements.

Use of excessive force will damage the elements. Use care when cleaning the elements.

c. The elements are cleaned using alcohol and a small round bristle brush (#1 stencil brush). An illustration of a typical stencil brush is provided by FIGURE 5-9. Apply alcohol to the brush. Remove dust and deposits from the elements with the brush. Starting with the top elements clean both sides of the element. Proceed by cleaning both sides of the lower elements. Reapply alcohol to the brush as necessary. Remove all contamination from the elements by repeated brushing.

d. Allow elements to dry at least 2 minutes before applying power to the sensor.

e. Inspect the elements after cleaning. They should be smooth and free of deposits. The bars of the cage should be clean. Any deposits on the cage bars may be removed using a damp lint-free cloth. All the bars of the cage should be straight. If not replacement of the sensor control assembly is required.

f. Perform sensor acceptance test of paragraph 5-4.2.3 after cleaning.

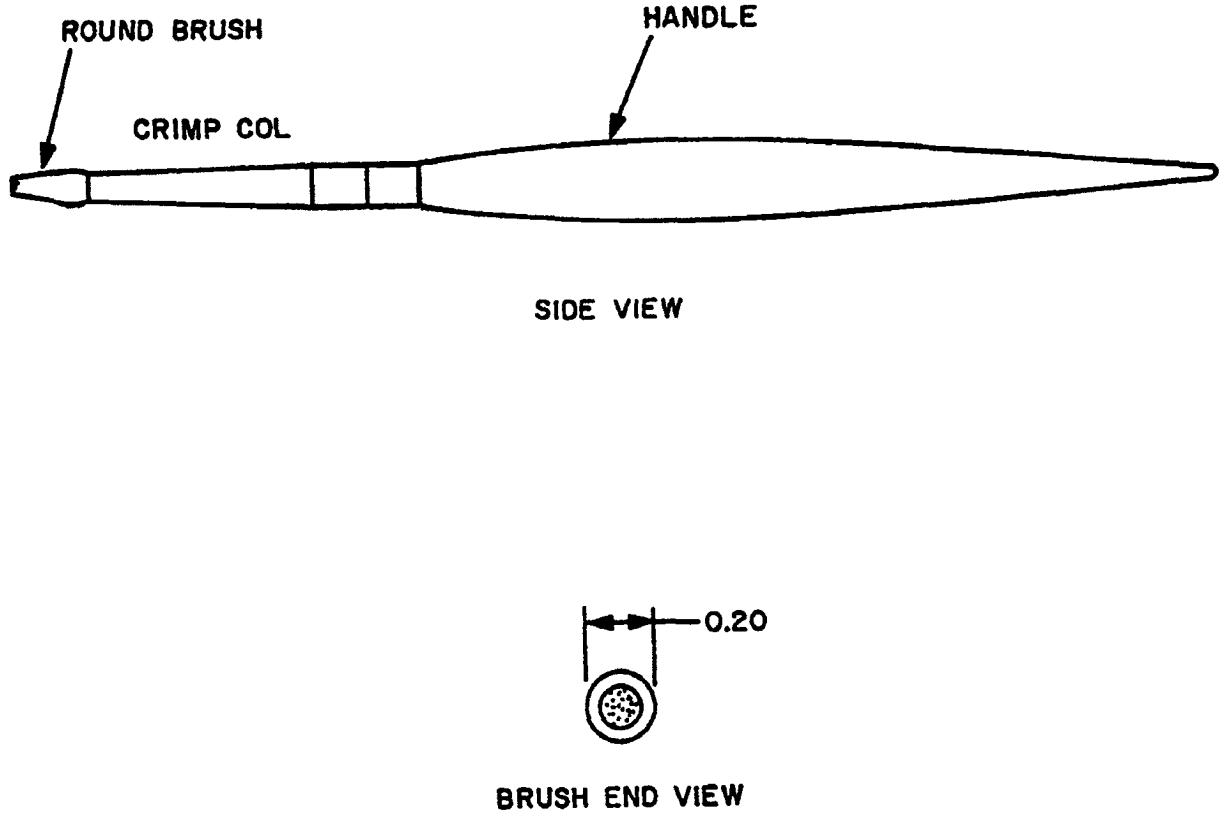


Figure 5-9. Illustration of Typical #1 Stencil Brush

Section II. SPECIAL MAINTENANCE

5-9 **GENERAL.**

This section provides bench test procedures required to verify satisfactory performance of the individual subassemblies used in the wind measuring set.

5-10 **BENCH TEST OF SUBASSEMBLIES.**

5-10.1 **Indicator/Recorder Display PCBA.** The following paragraphs provide acceptance test procedures which are used to verify satisfactory electrical performance of the display PCBA, P/N 6461-1017-1 (hereinafter referred to as the indicator display PCBA) and 6461-1017-2 (hereinafter referred to as the recorder display PCBA).

5-10.1.1 **Equipment Required But Not Supplied.** Following is a list of test equipment required to accomplish the display PCBA electrical performance tests.

a. Indicator/Recorder Subassembly Test Set, Sutron P/N 6700-1001.
b. Microprocessor PCBA 6461-1014-1 with software, Sutron P/N 8200-1002.
c. Okidata 182 Printer, or equivalent.
d. Printer Interface Cable, Sutron P/N 6411-1009-1, or equivalent.
e. Logic Probe.
f. Multimeter, Fluke 77, or equivalent.

5-10.1.2 **Test Requirements.** The Indicator/Recorder Subassembly Test Set and the Wind Sensor Simulator Software (hereinafter referred to as the sensor simulator) are used to simulate a sensor simulator assembly while performing the test procedures of paragraph 5-10.1.3. Test software, Sutron P/N 8200-1002, is used to test both the indicator display board and the recorder display board. The tests will differ only at 5-10.1.4, step k where the audio alarm and printer are exercised.

5-10.1.3 **Preliminary.** Prepare the display PCBA for test by performing the following preliminary procedures:

a. Place power switch CB1 in the off position.

b. Configure the microprocessor PCBA in the test set as shown in FIGURE 5-10.

c. Configure the display board in the test set as shown in FIGURE 5-10.

d. Position test set switches and potentiometer as follows:

S1 - MAS
S2 - IND (if testing display PCBA 6461-1017-1
REC (if testing display PCBA 6461-1017-2
S3 - 2
S4 - OFF
S5 - OFF
R1 - Mid way between off and on

e. If unit under test is display PCBA 6461-1017-1 skip to paragraph 5-10.1.4. If unit under test is display PCBA 6461-1017-2, continue. Connect printer interface cable to rear connector of printer and test printer connector. Turn on printer and depress printer SELECT front panel button until SELECT LED is on. Make sure the printer has paper installed.

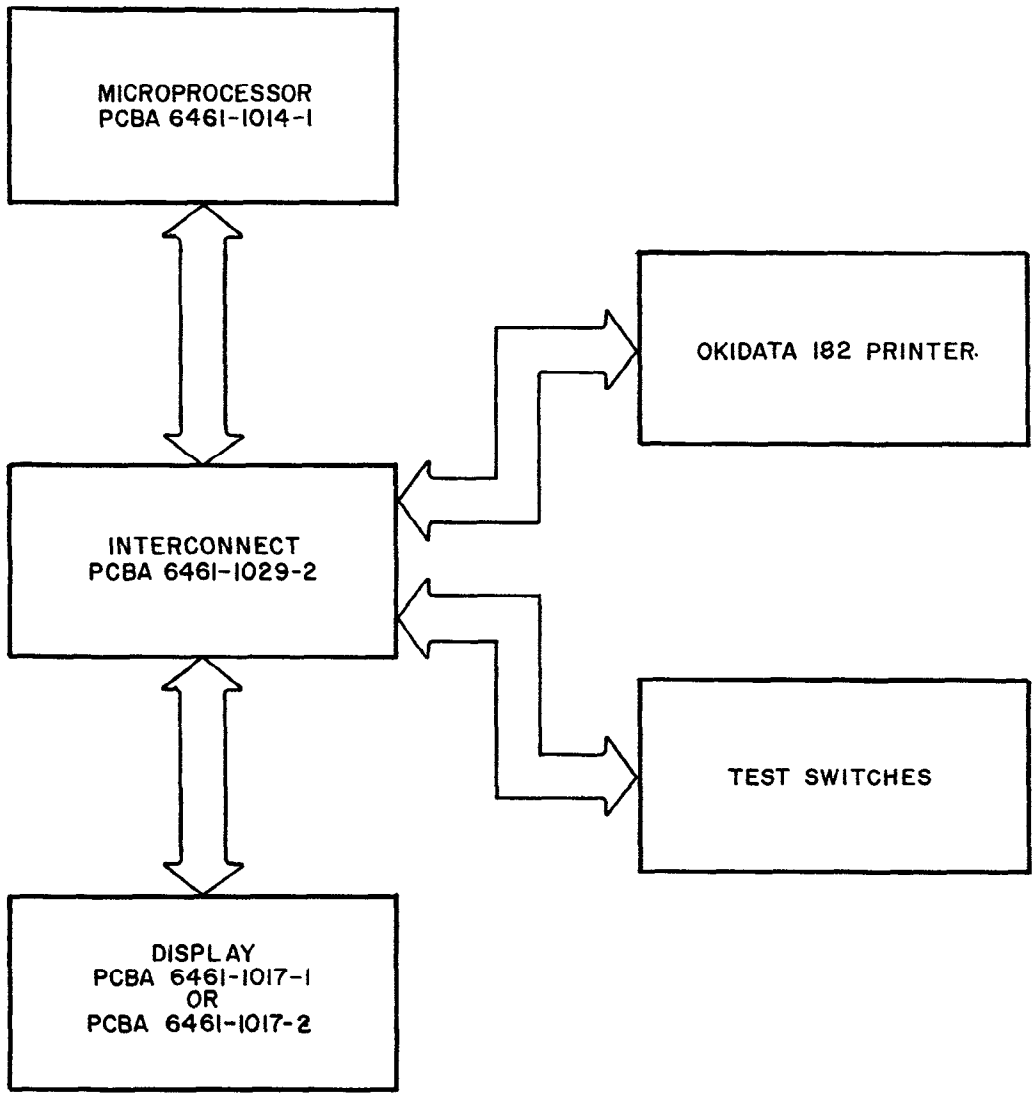


FIGURE 5-10. Indicator/Recorder Subassembly Test Set

5-10.1.4 **Test Procedures.** Perform the following test procedures in the order given.

a. Turn power switch CB1 to the ON position. Observe DS33 through DS36 and 7-segment LEDs. Verify that all 7-segment LEDs turned off; DS33 through DS36 turned on and off in sequential order.

(1) All 7-segment LEDs display 0 through 9 in sequential order.
(2) All 7-segment LEDs are off.

b. Use a multimeter (set to measure DC) to measure the following DC voltage test points on the solder side of the display PCBA;

Multimeter Connection		Limits	
+ Lead	-Lead	Min.	Max.
VLED TP10	GND TP8	6.1VDC	6.6VDC

c. Depress and hold SW9. Verify that all 7-segment displays display 8's.

d. Connect the Fluke logic probe between the +5V TP7 (red lead) and GND TP8 (black lead). Verify that the logic probe "high" LED is off and the "low" LED is on.

e. Move the red lead of the logic probe to TP2 on the display PCBA. Depress SW1 and observe the LEDs on the logic probe. Verify that the "high" LED on the logic probe pulses on and the "low" LED pulses off, then the "high" LED pulses off and the "low" LED pulses on.

f. Remove the logic probe and verify that all 7-segment LEDs display 0's.

g. Adjust R1 from full counterclockwise (CCW), then to full clockwise (CW), then back to mid position while observing the 7-segment displays. Verify that all 7-segment displays are off with R1 fully CCW and brightest display with R1 fully CW.

h. Depress SW3 and observe that all 7-segment LEDs display 1's.

i. Depress SW5 and observe that all 7-segment LEDs display 2's.

j. Depress SW7 and observe that all 7-segment LEDs display 3's.

k. Depress SW2 and observe the 7-segment LEDs.

(1) If the unit under test (UUT) is an indicator display PCBA, P/N 6461-1017-1, all 7-segment LEDs should display 5's.

(2) If the UUT is a recorder display PCBA, P/N 6461-1017-2, verify that all 7-segment LEDs display 4's, DS33 through DS36 turn on, audio alarm turns on, and printer prints out the message "Alarm On." Depress SW2 again and verify that DS33 through DS36 turns off, audio alarm turns off, and printer prints out message "Alarm Off."

l. Depress SW4 and verify that all 7-segment LEDs display 6's.

m. Depress SW6 and verify that all 7-segment LEDs display 7's.

n. Depress SW8 and verify that all 7-segment LEDs display 8's.

o. Depress SW10 and verify that all 7-segment LEDs are blank, except DS1, displays a 0.

p. Repeatedly depress SW10 and observe the 7-segment LEDs until DS9 is on. Verify that all 7-segment LEDs are off except for DS9 which should display an 8. DS2 through DS8 should turn on and off sequentially, displaying 1-7 respectively.

q. Repeatedly depress SW10 and observe the 7-segment LEDs until DS17 is on. Verify that all 7-segment LEDs are off except for DS17 which should display a 6. DS10 through DS16 should turn on and off sequentially, displaying 9 and 0-5 respectively.

r. Repeatedly depress SW10 and observe the 7-segment LEDs until DS32 is on. Verify that all 7-segment LEDs are off except for DS32 which should display a 1. DS18 through DS31 should turn on and off sequentially, displaying 7-9, 0-9, and 1 respectively.

s. Depress SW11 and observe the 7-segment LEDs.

(1) If the UUT is an indicator display PCBA, verify that DS1-DS3 display 1's and DS4-DS6 display 3's. DS32 displays 1, and all other 7-segment displays are off.

(2) If the UUT is a recorder display PCBA, verify that DS1-DS3 display 1's. DS4-DS6 display 2's, DS7-DS9 display 3's, DS32 displays 1, and all other 7-segment displays are off.

t. Position the test switches as follows:

S1 - BACKUP
S2 - Opposite position from startup (e.g., if an indicator, position to RECORDER)
S3 - 10
S4 - OFF
S5 - ON

u. Observe the 7-segment LEDs.

(1) If the UUT is an indicator display PCBA, verify that DS1-DS9 display 2's, DS32 displays a 2, and all other 7-segment LEDs are off.

(2) If the UUT is a recorder display PCBA, verify that DS1-DS3 display 2's, DS4-DS6 display 1's, DS7-DS9 displays 2's, and all other 7-segment LEDs are off.

v. Position the test switches as follows:

S1 - REGULAR
S2 - Opposite position from startup (e.g., if an indicator, position to RECORDER)
S3 - 10
S4 - ON
S5 - OFF

w. Observe the 7-segment LEDs.

(1) If the UUT is an indicator display PCBA, verify that DS1-DS6 display 2's, DS7-DS9 display 1's, DS32 displays a 3, and all other 7-segment LEDs are off.

(2) If the UUT is a recorder display PCBA, verify that DS1-DS3 display 2's, DS4-DS9 display 1's, DS32 displays a 3, and all other 7-segment LEDs are off.

x. Position the test switches as follows:

S1 - REGULAR
S2 - Opposite position from startup (e.g., if an indicator, position to RECORDER)
S3 - 10
S4 - ON
S5 - ON

y. Observe the 7-segment LEDs.

(1) If the UUT is an indicator display PCBA, verify that DS1-DS6 display 2's, DS7-DS9 display 1's, DS32 displays a 4, and all other 7-segment LEDs are off.

(2) If the UUT is a recorder display PCBA, verify that DS1-DS3 display 2's, DS4-DS9 display 1's, DS32 displays a 4, and all other 7-segment LEDs are off.

5-10.2 **Indicator/Recorder Microprocessor PCBA.** The following paragraphs provide acceptance test procedures which are used to verify satisfactory electrical performance of indicator/recorder microprocessor PCBA P/N 6461-1014, used in the indicator assembly. The procedure also contains instructions for calibrating various circuits on the microprocessor PCBA. These calibrations are necessary for normal board operation so they are performed at time of acceptance testing.

5-10.2.1 **Equipment Required But Not Supplied**
. Following is a list of test equipment required to accomplish the microprocessor PCBA electrical performance tests and calibration.

a. Oscilloscope.
b. Oscilloscope Probes (two required).
c. Digital Voltmeter.
d. Frequency Counter, Fluke Model 1953A, or equivalent.
e. Variable +12 Volt DC Power Supply.
f. Microsystem Troubleshooter, Fluke Model 9010A.
g. 8088 Interface Pod (for Fluke 9010A).
h. 9000A Logic Probe (for Fluke 9010A).
i. Indicator/Recorder Module Test Software Cassette for Fluke 9010A.
j. Indicator/Recorder Subassembly Test Set, Sutron P/N 6700-1001.
k. Potentiometer Adjustment Tool.
l. Alligator Test Leads (three required).
m. Grabber (E-Z Hook Type) Test Leads (two required).

5-10.2.2 **Preliminary.** Prepare the microprocessor PCBA for test by assembling the test figure per FIGURE 5-11 and performing the following procedures:

a. Remove the microprocessor PCBA from the indicator/recorder subassembly test set.

b. Attach the 8088 pod to the Fluke 9010A microsystem troubleshooter.

c. Remove the 8088 microprocessor (U5) from the microprocessor PCBA to be tested.

d. Plug the 40-pin connector of the interface pod into the microprocessor PCBA to be tested where the microprocessor IC (U5) would normally be plugged.

e. Plug the microprocessor PCBA into the test fixture.

f. Set the subassembly test set switches as follows:

S1 - MAS
S2 - IND
S3 - 2
S4 - ON
S5 - ON

g. Attach the Fluke 9000A logic probe to the Fluke 9190A.

h. Place jumper E4 of the microprocessor PCBA on pins 1 and 2.

NOTE

All frequency, voltage, and signal measurements made in the test procedures should be made with respect to TP4 (GND) unless otherwise specified.

5-10.2.3 **Power Supply Tests.** Perform the following test procedures in the sequence given to test the microprocessor PCBA power supply circuits.

5-10.2.3.1 **VBAT.** Test the power supply VBAT voltage as follows:

CAUTION

AC power to the indicator/recorder subassembly test set must be "off" while installing battery enable jumper E1 to prevent damage to the microprocessor PCBA.

a. With AC power to the indicator/recorder subassembly test set turned "off," install battery backup enable jumper E1.

b. Place ground probe of the DVM on TP15.

c. Place the positive probe of the DVM on TP5. Verify that the level is greater than 2.0VDC but less than 3.0VDC.

d. Turn on power to the Fluke 9010A microsystem troubleshooter.

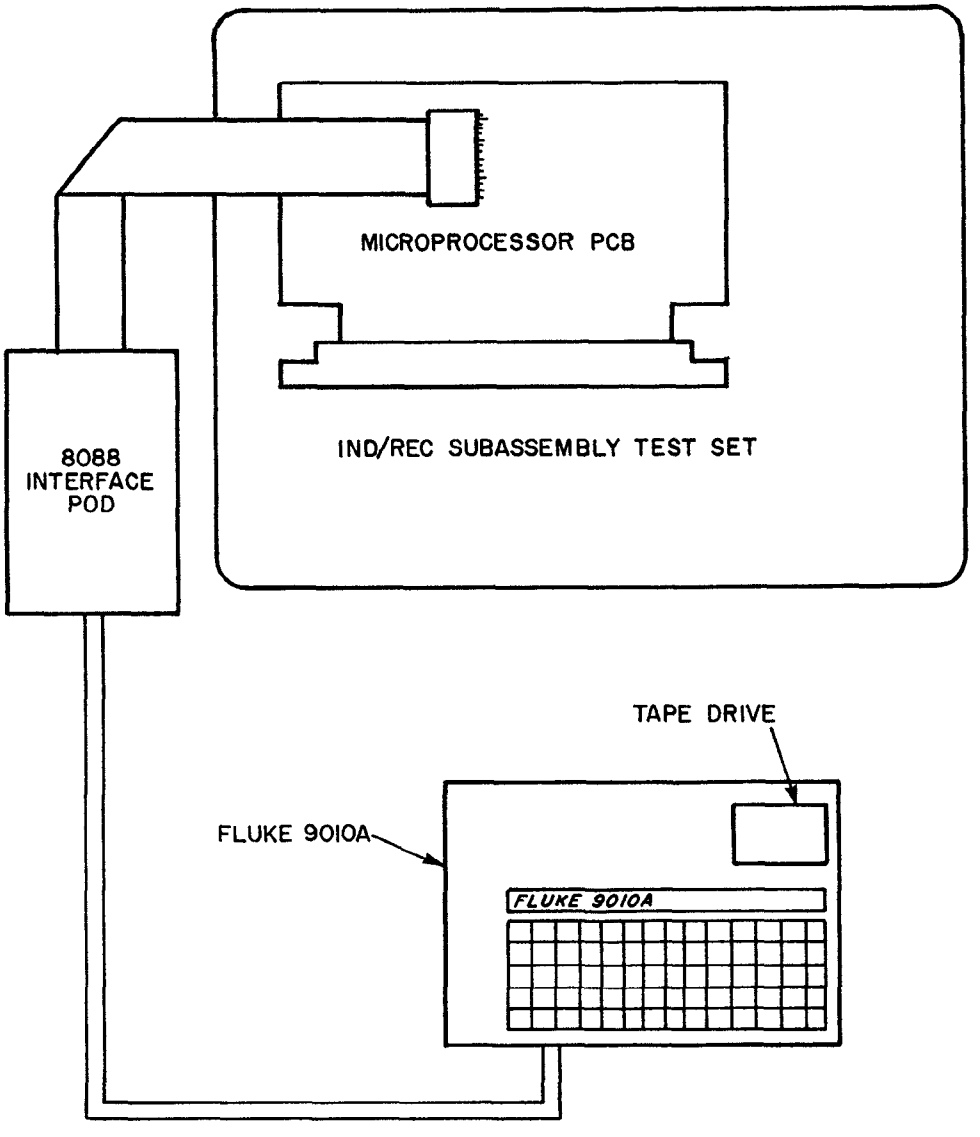


FIGURE 5-11. Test Setup for Microprocessor PCBA Calibration and Performance Test

5-10.2.3.2 **Power On Test Setup.** Perform the following setup before proceeding with the power supply test.

a. Turn on power to the Fluke 9010A microsystem troubleshooter.

b. Load the software cassette into the tape drive of the Fluke 9010A.

c. On the Fluke 9010A, press the READ TAPE button and then press the ENTER YES button.

d. Turn on power to the indicator/recorder subassembly test set. Display will flash randomly due to removal of 8088 microprocessor U5.

e. On the Fluke 9010A, press the RUN UUT button and then press the press the ENTER YES button.

5-10.2.3.3 **VUNR.** Test the power supply VUNR voltage as follows:

a. Set channel 1 of the oscilloscope as follows:

COUPLING - AC
HORIZONTAL - 1 MSEC/DIV
VERTICAL - 50 MV/DIV

b. Place the ground clip on the negative (-) side of C4 on the interconnect PCBA.

c. Place the channel 1 probe of the oscilloscope on E10 of the interconnect PCBA. Verify that ripple on the waveform is not more than 750 MV, and is typically 200 to 250 MV.

d. Change the channel 1 settings of the oscilloscope as follows:

COUPLING - DC
HORIZONTAL - 1 MSEC/DIV
VERTICAL - 2V/DIV

e. Verify that the signal displayed on the oscilloscope does not exceed 16.5 VDC or go below 8.0 VDC.

5-10.2.3.4 **+5 VDC.** Test the power supply +5 VDC voltage as follows:

a. Place the DVM ground probe on TP4.

b. Place the DVM positive probe on TP5. Verify that the level is +5 VDC + or -.2V.

5-10.2.3.5 **A+5 VDC.** Test the power supply A+5 VDC voltage as follows:

a. Place the DVM ground probe on TP4.

b. Place the DVM positive probe on TP1. Verify that the level is +5 VDC + or -.2V.

5-10.2.3.6 **+12 VDC.** Test the power supply +12 VDC voltage as follows:

a. Place the DVM ground probe on TP4.

b. Place the DVM positive probe on TP3. Verify that the level is +12 VDC + or -.5V.

5-10.2.3.7 **-12 VDC.** Test the power supply -12 VDC voltage as follows:

a. Place the DVM ground probe on TP4.

b. Place the DVM positive probe on TP16. Verify that the level is -12 VDC + or -.5V.

5-10.2.4 **4.9152 MHz Clock Test.** Perform the following test procedure to test the microprocessor PCBA 4.9152 MHz clock circuit.

a. Set channel 1 of the oscilloscope as follows:

COUPLING - AC
VERTICAL - 1V/DIV
HORIZONTAL - 50 nSEC/DIV

b. Place the ground clip on TP4.

c. Place the channel 1 probe of the oscilloscope on TP12. Verify that the signal displayed on the oscilloscope is a rectangular wave (33% high and 67% low) with a one cycle duration of approximately 200 nanosecond (nSEC).

d. Verify that the duty cycle of the signal is between 30% and 36% (duty cycle = time high/cycle time).

e. Set frequency counter controls as follows:

Range - 10 MSEC
Function - Freq-A
Channel A -
Slope - +
Coupling - AC
ATTEN - X10

f. Disconnect the probe from the oscilloscope and reconnect it to a frequency counter. Verify that the frequency is 4.9152 MHz + or - .05 MHz.

5-10.2.5 **Watchdog Timer Circuit.** Perform the following test procedures in the sequence given to test the microprocessor PCBA watchdog timer circuit.

5-10.2.5.1 **Disable WDTR.** Disable the watchdog timer as follows:

a. Turn off power to the test fixture.

b. Move the watchdog enable jumper (E4) to pins 2 and 3.

NOTE

E4 pins are numbered 3, 2, 1 left to right.

c. Depress "BUS" pushbutton on the Fluke 9010A.

d. Turn on power to the test fixture.

5-10.2.5.2 **Verify Pulsing.** Verify pulsing of the watchdog timer circuit as follows:

a. Set channel 1 of the oscilloscope as follows:

COUPLING - DC
HORIZONTAL - Any setting
VERTICAL - 1V/DIV

b. Connect the ground clip to TP4.

c. Place the channel 1 probe of the oscilloscope to TP21. Verify that the signal is a square wave with a period between 800 and 900 milliseconds.

d. Place jumper on pins 1 and 2 of E4.

5-10.2.6 **Undervoltage Lockout.** Perform the following test procedures in the order given to test the microprocessor PCBA undervoltage lockout circuit.

5-10.2.6.1 **Calibrate Threshold.** Calibrate the undervoltage lockout threshold as follows:

a. Turn off power to the test fixture.

b. Remove the AC connector from the back of the test fixture.

c. Set the output of the variable power supply to zero (0) volts.

d. Connect a grabber clip test lead between the positive terminal of the variable power supply to TP19 on the microprocessor PCBA. Make sure the power supply is turned all the way down.

e. Connect a grabber clip between the negative terminal of the variable power supply to TP20.

f. Monitor power supply with DVM (positive probe of DVM on positive terminal; negative probe of DVM on negative terminal).

g. Adjust power supply until DVM reads +7.75 volts.

h. Depress the "BUS" pushbutton of the Fluke 9010A. The display should read "Active force line ... loop ... ." Depress the "ENTER/YES" button.

i. Increase power supply output until the DVM reads +10.0 volts.

j. Place the logic probe of the Fluke 9010A on TP13 (RESET). Verify that the LED indicator of the probe is green (low).

5-10.2.6.2 **Verify Hysteris Points In Tolerance.** Verify hysteris points in tolerance as follows:

a. Adjust voltage on power supply down until the logic probe goes red (high).

b. Verify that the DVM reads between 7.0 and 9.5 VDC.

c. Turn off the power supply and remove test leads from power supply to the microprocessor PCBA under test.

d. Reconnect the AC power cord to the test set and turn test set power on.

5-10.2.7 **Modem Calibration.** Perform the following procedure to calibrate the modem circuits.

5-10.2.7.1 **Carrier Levels.** Calibrate carrier levels as follows:

a. Install carrier enable jumper E5.

b. Set channel 1 of the oscilloscope as follows:

COUPLING - AC
HORIZONTAL - .2MSEC/DIV
VERTICAL - .5V/DIV

c. Use the oscilloscope to monitor the waveform across the interassembly communications port by placing the channel 1 probe on E16 of the interconnect PCBA and the ground clip of the oscilloscope on E17.

d. Adjust R3 so that the level of the waveform observed on channel 1 of the oscilloscope is 2.2 volts peak-to-peak + or - 0.1 volts.

e. Set frequency counter controls as follows:

Range - 1.0 sec
Function - Freq A
Channel A -
Slope - +
Coupling - AC
ATTEN - X10

f. Disconnect the probe from channel 1 of the oscilloscope and reconnect to the frequency counter. Verify that the frequency counter reads 1200 Hz + or - 3 Hz. Use shortest test lead possible. Accuracy will be effected by the length of the leads.

g. Disconnect the probe from the frequency counter and reconnect back to channel 1 of the oscilloscope.

h. Place the channel 1 probe of the oscilloscope on IC U1 pin 4. See FIGURE 5-12 for location of U1 pin 4 on microprocessor PCBA. Change the vertical setting to .2V/DIV.

i. Place the ground clip of the oscilloscope on TP4.

j. Verify that signal is .75 volts peak-to-peak + or - .05 volts.

j. Verify that signal is .75 volts peak-to-peak + or - .05 volts.

5-10.2.7.2 **Receive Bias Distortion**. Calibrate receive bias distortion as follows:

a. On the Fluke 9010A, press the EXEC button, then press the 3 button, and then the "ENTER/YES" button. Verify that the Fluke display indicates "MODEM ADJUST RUNNING."

b. Set channel 1 of the oscilloscope as follows:

COUPLING - DC
HORIZONTAL - .5MSEC/DIV
VERTICAL - 1V/DIV

c. Place the channel 1 probe of the oscilloscope on TP10 (RXD).

d. Place the oscilloscope ground clip on TP4.

e. Adjust R1 until the signal displayed on the oscilloscope has an average duty cycle of 50% + or - 2%.

NOTE

A few percent of jitter is normal on this signal.

5-10.2.7.3 **Carrier Detect Level**. Calibrate the carrier detect level as follows:

a. Set channel 1 of the oscilloscope as follows:

COUPLING - AC
HORIZONTAL - .2MSEC/DIV
VERTICAL - 20MV/DIV

b. Place the channel 1 probe of the oscilloscope on E16 and place the ground clip on E17 of the interconnect PCBA.

c. Adjust R3 until signal displayed on the oscilloscope is 0.05 volts peak-to-peak + or - .005 volts approximately at 1200 Hz.

NOTE

This signal normally has 5-15 millivolts of high frequency noise, which should NOT be included in the 0.05V measurement.

d. Place the Fluke logic probe on TP2. If the logic probe indication is red (high), adjust R2 until it goes green (low).

e. Adjust R2 very slowly until indication of the logic probe just goes red (high).
Note: This is a critical adjustment. Turn R2 very slowly until level just goes red .

f. Change the channel 1 vertical setting to .5V/DIV.

g. Adjust R3 until the signal displayed on channel 1 of the oscilloscope is 2.2 volts peak-to-peak.

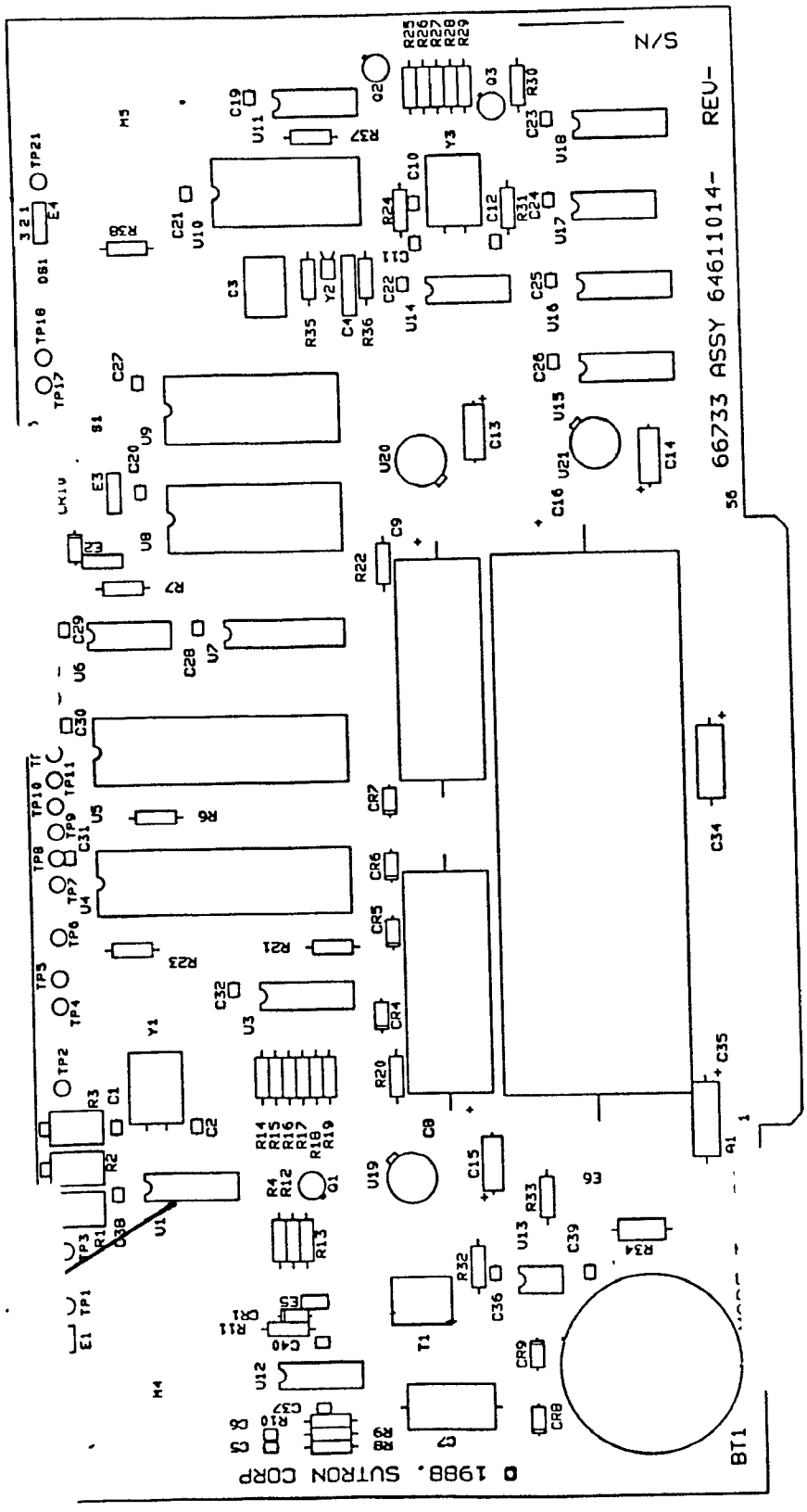


FIGURE 5-12. Microprocessor PCBA, Location of U1 pin 4.

h. Remove carrier enable jumper from E5 and place it on one pin for storage.

i. Verify that the logic probe shows green (low).

5-10.2.7.4 **Operational Software Tests.** Perform the following procedures to test the operational software.

5-10.2.7.4.1 **Display Power-Up.** Test the display power-up software as follows:

a. On the Fluke 9010A, press the "STOP" button and then the RUN UUT button and then press the ENTER/YES button.

b. The display should go through its power-up/self test sequence (all displays will start at 9 and count down to 0 with the audio alarm sounding when they reach 0; also, the switch indicator LEDs will flash in sequence.) Verify that the sequence occurs.

c. After the board completes this sequence, the display will come up in the normal operation mode. The time, date, and active sensor will come on constantly and the data fields will come on and flash.

5-10.2.7.4.2 **Status Display.** Test the status display software as follows:

a. Verify that the left-digit of the general status code field (labelled DS30) is a zero. If this code is not a zero, software has detected a fault on the microprocessor PCBA. Paragraph 5-3 explains how to interpret the built-in test codes to locate faults.

b. On the display PCBA, press the LAMP TEST (S9) button and hold it down.

c. While still holding down the LAMP TEST (S9) button, press the STATUS DISPLAY (S11) button.

d. Now release both buttons together and verify that the display comes on in the status mode. Refer to FIGURE 5-1, "Error Code Display" as to how this should look.

e. Verify that the time and date field is all zeros and should be flashing. Paragraph 5-3 shows how to interpret these error codes for fault location if they are not correct.

f. Refer to the normal operation mode by using the same sequence that was used in steps b, c, and d above.

5-10.2.7.4.3 **Clock Display and Calibration.** Test the clock display and calibration as follows:

a. Verify that the time display is on constantly and the seconds should be increasing.

b. Attach the oscilloscope probe to the frequency counter and set up the counter as follows:

Range - 10^1
Function - Period A
Channel - A
Slope - -
Coupling - DC
ATTEN - X10

c. Place the probe on TP9.

d. Place the ground clip on TP4.

e. On the Fluke 9010A, press the EXEC button and then the "2" button, and then press the "ENTER/YES" button. Verify that the display indicates "SETTING REAL TIME CLOCK."

f. Adjust C3 until the counter reads a period of .999990 ± .000010.

g. On the Fluke 9010A, press the "STOP" button and then the RUN UUT button and then the ENTER YES button. The display PCBA should come up in its power up/self test sequence.

5-10.2.7.4.4 **Time/Date Retention.** Test the time/date retention software as follows:

a. On the PCBA, press and release the SET/RUN (S1) button and verify that the Hours field (DS18, DS19) in the time display starts flashing. This is the active field.

b. Press the FIELD SELECT (S3) button to change the active field.

c. Press either the UP (S5) or DOWN (S7) button to set the field to the desired readout.

d. Repeat steps a through c to set the time and date to the current status. When finished, press and release the SET/RUN button again.

e. Turn off power to the test set.

f. Wait 5 seconds and then turn the test set back on.

g. After the display goes through its power up sequence, verify that the time and date displayed are current.

5-10.2.7.4.5 **Monitor AWDS**. Test the AWDS software as follows:

a. Set channel 1 of the oscilloscope as follows:

COUPLING - DC
HORIZONTAL - .2MSEC/DIV
VERTICAL - 5V/DIV

b. Place the oscilloscope channel 1 probe on AWDS port pin 4 on the interconnect PCBA.

c. Place the ground clip on TP4.

d. Verify that every 5 seconds, there will be RS449 data present on the port. Verify that the signal pulses between -5.5 volts and +5.5 volts + or -0.5 volts.

e. Move the Watchdog Enable jumper (E4) from pins 1 and 2 to pins 2 and 3.

5-10.2.7.5 **Normal Operations.** Test the normal operations of the microprocessor PCBA as follows:

5-10.2.7.5.1 **Microprocessor Operation.** Test the microprocessor operation as follows:

a. Turn off power to the test set.

b. Remove the 40 pin connector of the pod from the socket at U5.

c. Install the 8088 microprocessor IC into the socket at U5.

d. Turn on power to the test set.

e. Verify that the microprocessor PCBA goes through its normal power-up sequence as specified in paragraph 5-10.2.7.4.1, steps b and c.

5-10.2.7.5.2 **Battery Preservation.** Remove the battery jumper (E1) and place it on one pin for storage.

5-10.3 **Indicator/Recorder Interconnect PCBA.** The following paragraphs provide acceptance test procedures which are used to verify satisfactory electrical performance of interconnect PCBA 6461-1029-1 (hereinafter referred to as the indicator interconnect assembly) and interconnect PCBA 6461-1029-2 (hereinafter referred to as the recorder interconnect PCBA).

5-10.3.1 **Equipment Required But Not Supplied** Following is a list of test equipment required to accomplish the interconnection PCBA electrical performance test.

a. Indicator/Recorder Subassembly Test Set, Sutron P/N 6700-1001.

b. Display PCBA Test EPROM, Sutron P/N 8200-1002.

c. Blank Microprocessor PCBA, Sutron P/N 1331-1014, with C16 installed (see section 4.3.1).

d. Oscilloscope, Tektronix Model 2213A, or equivalent with X10 Probe.

e. Multimeter, Fluke 77, or equivalent.

f. Test Leads (three required).

5-10.3.2 **Regulator Circuit Test.** Perform the following procedures in the sequence given to test the interconnect PCBA regulator circuit.

a. Place the interconnect board on the Indicator Test Set (P/N 6700-1001). Connect the power transformer of the test set into connector J5.

b. Use the labeled Faston connectors for the following items to the interconnect board on the indicator interconnection diagram (see T.O. 31M1-2FMQ13-3, FIGURE 24).

(1) Voltage Regulators U1 (E10-E12) and U2 (E13-E15)
(2) Breaker Assembly (E5-E7)
(3) Potentiometer Assembly (E18, E19)
(4) Configuration Switch Assembly (E20-E22)

c. Remove jumper E1, E3 and E4 and install the corresponding connectors from the test set.
d. Plug in the blank microprocessor PCB with C16 installed, item 4 on the equipment list. (This avoids the possibility of damaging a fully populated PCB in case a high voltage is produced by a faulty interconnect PCBA.)

e. Plug in the AC power cable and turn the breaker switch on.

f. Set the control knob on the multimeter to the DC voltage position and connect the positive probe to TP3 and the negative probe to TP4. The value should be between 4.8 and 5.2V.

g. Connect TP4 to TP8. Connect the positive probe of the multimeter to TP9 and the negative probe on TP8. The value should be between 5.90 and 6.8V.

h. Remove connection between TP4 and TP8.

NOTE

DO NOT PROCEED WITH TESTING IF EITHER OF THE PREVIOUS READINGS ARE OUTSIDE THE SPECIFIED LIMITS.

5-10.3.3 **Microprocessor and Display PCBA Operation Test.** Perform the microprocessor and display PCBA operation test as follows:

a. Turn off the breaker switch and remove the blank microprocessor PCBA.

b. Install the display PCBA test EPROM on the test set's microprocessor PCBA.

c. Plug the test set's microprocessor and display PCBAs into the interconnect PCBA.

d. Turn the breaker switch on.

e. Observe the 7-segment LED displays and LED lamps on the display PCBA and check to see that all four lamps come on one at a time, and that all of the 7-segment displays come on and count from 0 through 9.

f. Push switch S11 on the display PCBA.

(The 7-segment displays should now show the state of the configuration switch and jumpers E1 to E4 on DS1 through DS9 and DS32 as given in the following steps.)

g. On the test set control panel, place configuration switch (S1) in the "MAS", "BAC", and "REG" positions and verify that DS7-9 display a "3", "2", and "1", respectively.

h. On the test set control panel, set switch S3 to 2 to connect pins 2 and 3 of E1 and verify that DS1-3 display a "2". Set switch S3 to 10 to connect pins 1 and 2 of E1 and verify that DS1-3 display a "1".

i. If a 6461-1029-1 interconnect board is being tested, verify that a "1" appears on DS4-6. If a 6461-1029-2 board is being tested, a "2" should appear.

j. On the test set control panel set switches S4 and S5 to ON to connect pins 1 and 2 of E3 and E4 and verify that DS32 displays a "4".

k. On the test set control panel set switches S4 and S5 to OFF to disconnect pins 1 and 2 of E3 and E4 and verify that DS32 displays a "1".

5-10.4 **Sensor Control Assembly.** The following paragraphs provide acceptance test procedures which are used to verify satisfactory electrical performance of sensor control assembly P/N 6661-1013.

5-10.4.1 **Equipment Required But Not Supplied.** Following is a list of test equipment required to accomplish the sensor control assembly electrical performance tests.

a. Sensor Control Assembly Software Disk, Sutron P/N 8202-1018.
b. Sensor Control Assembly UUT, Sutron P/N 6661-1013.
c. Modem, Universal Data Systems Model 202T, or equivalent.
d. IBM PC Compatible Computer.
e. IBM PC compatible Parallel Printer.
f. RS-232 Cable (used to connect modem to computer).
g. Tip and Ring Cable, Modular Phone Plug to Alligator Clip (used to connect the modem to UUT).
h. Sensor Power Assembly (P/N 66733 ASSY 6211-1006-1).

5-10.4.2 **Preliminary.** Prepare the sensor control assembly for test by performing the following test procedures:

a. Install software disk (P/N 8202-1018) in drive A. Turn on the computer and press the ALT, CTRL, and DEL keys simultaneously.

b. If the computer prompts for the time, enter it in 24-hour format HH:MM (Return). Then it will prompt for the date, which is entered as MM-DD-YY (Return).

c. At the A:> prompt, enter SCA followed by the Return key to load the program.

d. Connect the RS-232 modem cable to the computer and modem, and the tip and ring cable modular end to the modem. The alligator clips are attached to the two terminal screws closest to the wind sensor power supply. The sensor control assembly is fitted into the power supply assembly and the cable attached.

e. Power up the modem and the wind sensor power supply assembly.

5-10.4.3 **Test Procedures.** Perform the following test procedures in the order given:

a. The test starts by asking the operator to enter their initials. Enter your initials and press RETURN to start the test. The program will then ask the operator to verify the date. The program will instruct the operator to install a "zero cap" over the control assembly. (The "zero cap" can be a plastic bag placed over the cage portion of the control assembly to block air flow around the elements.) The program will then ask if the control assembly has had power applied to it for the last 30 seconds or more. If it has been at least 30 seconds since the power supply assembly has been turned on, answer "Y". If not, answer "N" and wait for the test to start after the 30-second countdown.

b. The test takes 3 minutes or 180 seconds. The data from the control assembly may change during this time, as the screen is periodically refreshed. At the end of the 180-second countdown, the program will display the results of the test. The results will be printed on the printer. The print out will give pass/fail results.

5-10.5 **Sensor A and B Microprocessor PCBA**. The following paragraphs provide acceptance test procedures which are used to verify satisfactory electrical performance of microprocessor PCBA P/N 6461-1015 (hereinafter referred to as sensor A microprocessor PCBA) and microprocessor PCBA 6461-1041 (hereinafter referred to as sensor B microprocessor PCBA).

5-10.5.1 **Equipment Required But Not Supplied**. Following is a list of test equipment required to accomplish the sensor A and B microprocessor PCBA electrical performance tests.

a. A and B Microboard Test Fixture, Sutron P/N 6700-1012.
b. A and B Microboard Test EPROM, P/N 8200-1012A.
c. A and B Microboard Test Software for Fluke 9010A.
d. Fluke 9010A and 8088 test pod.
e. Oscilloscope, Tektronix 2213, or equivalent.
f. Frequency Counter, Fluke 1953A, or equivalent.
g. Digital Multimeter, Fluke 77, or equivalent.
h. ADDS VRT-90, RS-232 compatible display terminal, or equivalent.

5-10.5.2 **Preliminary**. Prepare the sensor A and B microprocessor PCBA for test by performing the following procedures:

a. Connect the test fixture to a 115 VAC outlet.

b. Remove J1 on the A microprocessor PCBA and store on one post.

c. Remove microprocessor U2 on board B (1014) and plug the Fluke 9010A into the microprocessor socket U2 on board B (1014).

d. Plug cable connector onto mating connector on the test fixture.

e. Install the test EPROM P/N 8200-1012A in socket U17 of board B (1014).

f. Insert "micro A and B" test tape P/N 8200-1039 into the Fluke 9010A and depress READ TAPE and ENTER/YES buttons on the Fluke keyboard to read tape.

g. Connect dummy head 1 to card edge connectors (observe polarity). Each connector is marked for the board it goes into for pin #1.

h. Turn the test fixture power on.

5-10.5.3 **Power Supply Test**. Perform the power supply test as follows:

a. Connect the digital multimeter ground lead to the ground lug on the test fixture.

b. Using the digital multimeter (set to measure DC voltage), verify that the voltages at the following test points on microprocessor board A are within the limits specified:

Power Supply Board A Test Point	Limits Min.	Max.
TP4	14.25 VDC	15.75 VDC
TP5	11.4 VDC	12.6 VDC
TP6	4.75 VDC	5.25 VDC
TP7	-0.05 VDC	+0.05 VDC
TP8	-15.75 VDC	-14.25 VDC

c. Using the digital multimeter (set to measure DC voltage), verify that the voltages at the following test points on microprocessor board B are within the limits specified:

Power Supply Board B Test Point	Limits Min.	Max.
TP7	14.25 VDC	15.75 VDC
TP10	11.4 VDC	12.6 VDC
TP11	4.75 VDC	5.25 VDC
TP8	-0.05 VDC	+0.05 VDC
TP9	-15.75 VDC	-14.25 VDC

5-10.5.4 **Watchdog Timer Test**. Perform the watchdog timer test as follows:

a. Connect the frequency counter probe ground to the test fixture ground lug.

b. Set the counter as follows:

Power - ON
Mode - Cont
Range - 10^{0}
Function - Period A
Slope - +
Couple - AC
ATTEN - X1

c. Attach the frequency counter probe to TP1 on board B (1041) and then reset the counter. Verify that the period is 370-540 milliseconds.

d. Attach J1 on board A to both posts. Verify that TP1 is low (0V) when checked with an oscilloscope or digital multimeter.

5-10.5.5 **Functional Test**. Perform a functional test of the sensor A and B microprocessor PCBA as follows:

a. Bus Test, RAM Test, and ROM Test are automatic.

b. Observe the following sequence of buttons on the Fluke 9010A keyboard: "Exec", "1", "Enter/Yes".

5-10.5.6 **Read Status Register Test**. Perform the read status register test as follows: (The text in quotations is displayed on the Fluke 9010A.)

a. "REMOVE J5-J6, TURN E25 OFF". Remove straps from J5-J6 and turn E25, located on the test fixture front panel, to its off (down) position.

b. "SHORT ACROSS J6". Use a strap or other suitable object to jumper J6.

c. "REMOVE J6, SHORT ACROSS J5". Remove the strap from J6 and place it across J5.

d. "REMOVE J5, SHORT ACROSS J4". Remove the strap from J5 and use a suitable object to short across J4.

e. "REMOVE J4, SHORT ACROSS J3". If this display is seen, check that the soldered in jumper is installed.

f. "REMOVE J4, SHORT ACROSS J2". **DO NOT** remove J3 since it is soldered in, but just short across J2 with a suitable object.

g. "REMOVE J2, TURN ON E25". Remove the strap from J2 and turn switch E25, located on the test fixture front panel, to its ON (up) position.

h. "TURN ON E25". Accompanied by a beep, this indicates successful completion of the read status register set. Switch E25 should be switched off (down position).

5-10.5.7 **Heater Enable Test**. Perform the heater enable test as follows:

a. Check that the HEATER light on the test fixture front panel is on and depress the YES or NO button on the Fluke 9010A keyboard accordingly.

b. Check that the HEATER light on the test fixture front panel is off and depress the YES or NO button on the Fluke 9010A keyboard accordingly.

NOTE

If the NO button is depressed more than three times, FAILED HEATER ENABLE TEST will be displayed.

5-10.5.8 **NMI Disable Test.** Perform the NMI disable test as follows:

a. Check U18 pin 4 on board B (1041) for less than 0.1V with DMM.
b. Press "CONT" button on Fluke 9010A keyboard.
c. Check U18 pin 4 on board B (1041) for greater than 4.75 VDC.
d. Press "CONT" button on Fluke 9010A keyboard.
e. Press "CONT" button on Fluke 9010A keyboard.

5-10.5.9 **Function Software Test.** Perform the function software test as follows:

a. Set oscilloscope as follows:

trigger - internal source (normal source)
- D.C. couple
- norm mode
time/div - 10 ms/division
volts/div - 1 V/division
slope - negative

b. Connect the ground lead of a 10:1 oscilloscope probe to the test fixture ground lug and the probe to U8 pin 5 on micro-board A (1015), depress "CONT" on Fluke 9010A keyboard.

c. Observe the oscilloscope for a sawtooth waveform, 4.6 V ± 10% in amplitude and 70 ms ± 10% in period.

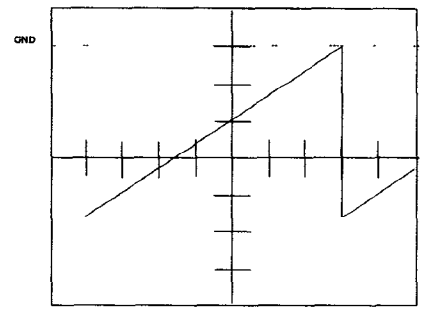


FIGURE 5-13. Long Ramp Waveform

This waveform should also be observed at:

U9 pin 5 (1015) micro-board A.
U13 pin 5 (1041) micro-board B.
U14 pin 5 (1041) micro-board B.

d. Change oscilloscope volts/div. to 50 mV/div., change oscilloscope time/div. to 1 ms/div. and press "CONT" on Fluke 9010A.

e. Probe U8 pin 5 on micro-board A (1015), observe the oscilloscope for a sawtooth waveform, 272 mV ± 10% in amplitude, and 4.3 ms ± 10% in period.

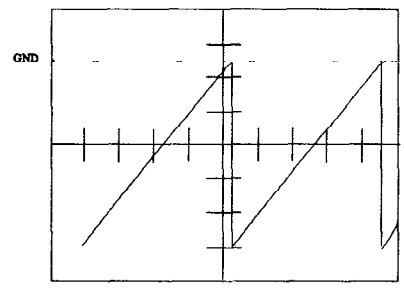


FIGURE 5-14. Short Ramp Waveform

The display should also appear at:

U9, pin 5 on micro-board A (1015)
U13, pin 5 on micro-board B (1041)
U14, pin 5 on micro-board B (1041)

5-10.5.10 **UART and Status Test.** Perform the UART and status test as follows:

a. Depress "CONT" on Fluke 9010A keyboard.

b. The terminal should be set as follows:

9600 baud
no parity
1 stop bit

c. Press "CTRL B", "CTRL Q", on terminal keyboard.

d. Wait at least one minute and then press CTRL-S on the terminal keyboard. Verify that the displayed values for the parameters given below are within the limits provided with the test fixture.

X+	5v
X-	V Baro
Y+	V Temp
Y-	Status
Temp	Spur cnt

5-10.5.11 **Programmable Timer Test.** Perform the programmable timer test as follows:

a. Depress the "CONT" button on the Fluke 9010A keyboard.

b. Set frequency counter as follows:

Power:	ON
Mode:	Cont
Range:	1 sec
Function:	Freq. A
Slope:	+
Couple:	A.C.
ATTEN	X10

c. Connect probe ground clip to ground lug on test fixture.

d. Connect probe to U11 pin 13, on board B (1041).

e. Verify that the frequency is between 38.3962 kHz and 39.4038 kHz.

5-10.5.12 **Microprocessor Test.** Perform the microprocessor test as follows:

a. Turn off power to test set.
b. Disconnect fluke pod from 8088 socket.
c. Install microprocessor.
d. Remove J1 (watchdog) mini-jumper.
e. Install J5 and J6 mini-jumpers in the 1-2 position.
f. Turn on power and observe display screen for proper microprocessor functioning, i.e. the status screen seen previously in step 5-10.5.10 - d.

5-10.6 **Sensor Power Supply Assembly**. The following paragraphs provide acceptance test procedures which are used to verify satisfactory electrical performance of sensor power supply assembly P/N 6461-1038 (hereafter referred to as the power supply). The power supply consists of two PCBAs, P/Ns 6461-1039 and 6461-1043 hereafter referred to as the power front PCBA and the power back PCBA, respectively.

5-10.6.1 **Equipment Required But Not Supplied**. Following is a list of test equipment required to accomplish the interconnection PCBA electrical performance test.

a. Oscilloscope Tektronix 2213A or equivalent
b. Two Scope Probes
c. Digital Volt Meter, Fluke model 77 or equivalent
d. Frequency Counter, Fluke 1953A or equivalent
e. Fluke 9010A Microsystem Troubleshooter
f. 8088 Interface Pod (for Fluke 9010A)
g. 9000 Logic Probe (for Fluke 9010A)
h. Sensor Software Cassette for Fluke 9010A, Sutron P/N 8200-1008
i. Sensor Subassembly Test Set, Sutron P/N 6700-1012
j. Potentiometer Adjustment Tool
k. Two Alligator Test Leads

5-10.6.2 **Preliminary**.

a. Set the power switch of the test fixture to the OFF position.

b. Connect the lead from the test fixture marked AC LINE to the tab marked E12 on the power front PCBA.

c. Attach the lead from E14 of the power front PCBA to the terminal marked NEU on the test fixture.

d. Plug the test fixture cable marked DUMMY LOAD into J1 on the power front PCBA.

e. Plug the test fixture marked TRANSFORMER into J2 of the power front PCBA.

f. Connect the 8000 interface pod and the 9000A logic probe to the Fluke 9010A.

g. Plug the 40-pin DIP connector of the 8088 interface pod into the 40-pin IC socket marked "8088" on the test fixture.

h. Turn on the Fluke 9010A. Load the software cassette into the Fluke 9010A tape drive and press the following tape sequence:

READ TAPE
ENTER/YES

The Fluke 9010A will read the tape and indicate "READ TAPE OK" when complete.

i. Set the switches marked X+, X-, Y+, and Y- to the OFF position.

j. Verify that the following jumper on the power front PCBA are configured as follows:

E10 - open, jumper on pin 1 only
E15 - jumpers on pins 1-6, 2-3, 4-5 (115 VAC operation)
E24 - open, jumpers on pin 1 only and pin 4 only
E25 - pins 1-2 jumpered

5-10.6.3 **DC Power Supply Test**. Set the power switch of the test fixture to the ON position and perform the following measurements on the power front PCBA with the multimeter:

a. With the multimeter set for DC voltage measurements, connect the positive probe to E1 and the negative probe to TP7. The voltage should be between 11.2VDC and 12.4VDC.

b. Set the multimeter to read AC voltage. The reading should be less than 0.12VAC.

c. With the multimeter set for DC voltage measurements, connect the positive probe to TP4 and the negative probe to TP7. The voltage should be between 4.8VDC and 5.2VDC.

d. Set the multimeter to read AC voltage. The reading should be less than 0.10VAC.

e. With the multimeter set for DC voltage measurements, connect the positive probe to TP9 and the negative probe to TP7. The voltage should be between 14.25VDC and 15.75VDC.

f. Set the multimeter to read AC voltage. The reading should be less than 0.015VAC.

g. With the multimeter set for DC voltage measurements, connect the positive probe to TP5 and the negative probe to TP7. The voltage should be between -14.25VDC and -15.75VDC.

h. Set the multimeter to read AC voltage. The reading should be less than 0.015VAC.

5-10.6.4 **Element Driver Test.**

a. Turn off the power to the test fixture. Unplug the cable marked DUMMY LOAD from the power front PCBA. Connect the test fixture cable marked MICROPROCESSOR PCBA to J1 of the power from PCBA.

b. Set the power switch of the test fixture to the ON position.

c. Press the following sequence of buttons on the Fluke 9010A:

"EXECUTE"
"5"
"ENTER/YES"

Fluke 9010A will display the message "ELEMENT DRIVERS ENABLED".

d. Turn the switch of the test fixture marked X+ to the ON position. Set the multimeter setting to DC voltage. Measure the voltage across the load resistor marked X+ on the test fixture. Place the positive probe on the lead marked "+". Place the negative probe on the lead marked "-". The voltage should be between 10.0 and 12.4 VDC.

e. Turn the switch on the test fixture marked X+ to the OFF position. The voltage across the X+ load resistor should be 0.35 to 0.52 VDC.

f. Turn the switch of the test fixture marked X- to the ON position. Set the multimeter setting to DC voltage. Measure the voltage across the load resistor marked X- on the test fixture. Place the positive probe on the lead marked "+". Place the negative probe on the lead marked "-". The voltage should be between 10.0 and 12.4 VDC.

g. Turn the switch on the test fixture marked X- to the OFF position. The voltage across the X-load resistor should be 0.35 to 0.52 VDC.

h. Turn the switch of the test fixture marked Y+ to the ON position. Set the multimeter setting to DC voltage. Measure the voltage across the load resistor marked Y+ on the test fixture. Place the positive probe on the lead marked "+". Place the negative probe on the lead marked "-". The voltage should be between 10.0 and 12.4 VDC.

i. Turn the switch on the test fixture marked Y+ to the OFF position. The voltage across the Y+ load resistor should be 0.35 to 0.52 VDC.

j. Turn the switch of the test fixture marked Y- to the ON position. Set the multimeter setting to DC voltage. Measure the voltage across the load resistor marked Y- on the test fixture. Place the positive probe on the lead marked "+". Place the negative probe on the lead marked "-". The voltage should be between 10.0 and 12.4 VDC.

k. Turn the switch on the test fixture marked Y- to the OFF position. The voltage across the Y-load resistor should be 0.35 to 0.52 VDC.

5-10.6.5 **Modem Adjustments**.

5-10.6.5.1 **Carrier Levels**.

a. Install carrier enable jumper (E10) on power front PCBA.

b. Set scope, channel 1, to these settings (coupling = AC, horizontal = .2 MSEC/DIV, vertical = .5 V/DIV.

c. Put probe on E26 of power front PCBA of test fixture, the ground clip of the scope probe on E27.

d. Adjust R8 so that signal is 2.2 volts p-p, ± 0.1 volts.

e. Remove the probe from the oscilloscope and connect the channel 1 probe to the frequency counter. Set controls on counter as follows:

Range - 2.0 S
Function - Freq A
Channel - A
Slope - +
Coupling - AC
ATTEN - X10

f. Verify that the frequency is 1200 Hz; ±3Hz.

g. Connect the probe back to the scope.

h. Put channel 1 probe on U3 pin 4. Change the vertical setting 0.2 V/DIV.

i. Put the ground clip on TP7.

j. Verify that the signal is 0.75 volts p-p, ± .05 volts.

5-10.6.5.2 **Receive Bias Distortion**.

a. On Fluke 9010A press the "EXEC" button, then the "2" button, and then the "ENTER/YES" button.

b. Fluke display should say "MODEM ADJUST RUNNING".

c. Set scope, to these settings (coupling = DC, horizontal = .2 MSEC/DIV, vertical = 1 V/DIV).

d. Put probe on TP2 of the power front PCBA.

e. Put the ground clip on TP7.

f. Adjust R9 until signal has an average duty cycle of 50%, ± 2%.

NOTE

A few percent of jitter is normal on this signal.

5-10.6.5.3 **Carrier Detect Level**.

a. Set scope, to these settings (coupling = AC, horizontal = .2 MSEC/DIV, vertical = 20 MV/DIV).

b. Put scope probe on E26 and put ground on E27 of the power front PCBA.

c. Adjust R8 until signal is 0.05 volts p-p, ± .005 volts, at 1200 Hz (frequency must be calculated from scope horizontal axis reading).

NOTE

This signal normally has 5-15 millivolts of high frequency noise, which should NOT be included in the 0.05 Vpp measurement.

d. Put logic probe on TP3.

e. If the logic probe indication is red, adjust R10 until it goes green (low).

f. Adjust R10 very slowly until indication on logic probe just goes red (high).

NOTE: Adjustment of R10 is a critical adjustment.

g. Change vertical setting to .5 V/DIV.

h. Adjust R8 until channel 1 signal is 2.2 volts p-p.

i. Remove carrier enable jumper from E10 and place it on one pin for storage.

j. Verify that the logic probe shows green (low).

k. On the Fluke 9010A, press the "stop" button.

5-10.6.6 **De-icing Heater Test**.

a. On the Fluke 9010A, press the following button sequence:

"EXECUTE"
"4"
"ENTER/YES"

The Fluke will display "HEATER ON / 50%"

WARNING

THE FOLLOWING VOLTAGE MEASUREMENT POINT HAS 115 VAC POTENTIAL. USE CAUTION WHEN MEASURING VOLTAGE. FAILURE TO DO SO CAN CAUSE INJURY OR DEATH.

b. Set the multimeter to measure AC voltage. Connect the probes to the test fixture terminals marked HEATER OUTPUT.

c. Verify that voltage output cycles on for 5 seconds and off for 5 seconds. The ON cycle should range between 100 to 125 VAC. The OFF cycle should be less than 1 VAC.

d. Test complete. Remove power from test fixture.

5-11 SUBASSEMBLY TROUBLESHOOTING.

This section contains the troubleshooting section for the following subassemblies: indicator/recorder display PCBA, indicator/recorder microprocessor PCBA, indicator/recorder interconnect PCBA, sensor control assembly, sensor A and B microprocessor PCBA and sensor power supply PCBA. These tables start the troubleshooting list at the point where the troubleshooting lists of Section I of Chapter 5 leave off. The respective PCBA should be tested using the test fixture described in paragraph 5-10, Bench Test of Subassemblies.

5-11.1 **Indicator/Recorder Display PCBA.** Refer to FIGURES 22 and 26 of the Circuit Diagram Manual (T.O. 31M1-2FMQ13-3) when using table 5-31 for troubleshooting the Indicator/Recorder Display PCBA.

Table 5-31. Indicator/Recorder Display PCBA

Problem	Probable Cause	Remedy
1. All Displays off	a. Loss of VIRef	a1. Check that base of Q31 is less 1 volt. If not, check for high RESET line. a2. If RESET is low, check that U10, pin changes voltage level when control is changed. If no change occurs, replace Q31. a3. Check that changing INTENSITY control causes U10 pin 1 to change. If voltage does not change replace U10.
	b. Loss of VLED	b. Check for 5 volts at TP10 (VLED). If not present localize power supply or continuity problem.
2. Top half of LEDs do not light	Not receiving input Voltage	Check U14 inputs and outputs. Replace if defective.
3. Bottom half of LEDs do not light	Not receiving input Voltage	Check RN1 resistance. Check U15 input and outputs. Check RN2 resistance.
4. Single LED display does get light associated	Blown LED	Replace LED
5. Pair of LEDs do not light	Blown Transistor	Check output of transistor associated with cathode side of LED (Q18-Q29).

Table 5-31. Indicator/Recorder Display PCBA - CONT

Problem	Probable Cause	Remedy
6. LEDs 1, 2, 3, 4, 5, 6, 11, 12, 18, 19, 20, 21, 22, 23, 24, and 25 do not light	NE S91 not latching	Check U8
7. LEDs 7, 8, 9, 10, 13, 14, 15, 16, 17, 26, 27, 28, 29, 30, 31, and 32 do not light	NE S91 not latching	Check U7
8. Single segment will not light	Malfunctioning driver circuit	Check associated driver circuit for bad segment
	LED bad	Replace LED
9. Single segment will not dim out completely	Malfunctioning driver circuit	Check driver circuit (Note: This is often caused by a short to another driver circuit.)
10. Single segment stays 100% ON	Driver circuit transistor shorted	Replace associated transistor
11. Nonsense or incorrect display	Corrupted data	Check TP1 for 2.4576MHz. Check TP4 and TP2 for proper signals. Check U3 pin 9 for active resets.
12. SENSOR SELECT LED will not light	Faulty LED	Replace LED
13. Button does not function correctly	Faulty button	Replace button
14. ALARM tone unstable	U1 (LS123) faulty	Replace U1 (LS123)
15. Printer output incorrect	Failed latch in printer circuit	Check U5 outputs and inputs

5-11.2 **Indicator/Recorder Microprocessor PCBA**. Refer to FIGURES 19, 20, 21, and 25 of the Circuit Diagram Manual (T.O. 31M1-2FMQ13-3) when using table 5-32 for troubleshooting the Indicator/Recorder Microprocessor PCBA.

Table 5-32. Indicator/Recorder Microprocessor PCBA

Problem	Probable Cause	Remedy
1. Time and Date reset at power-up	a. Discharged battery	a. Check for 2.5 ± 0.5 VDC with (-) probe on cathode side of CR8 and (+) probe on Pin 1 of E1. No Voltage: Replace Battery
	b. Bad connection between battery and RAM	b1. Check for 2.5V ±0.5 VDC between TP5 and TP15 with E1 jumper installed. NO: Check for continuity to test points.
		b2. Check for 2.5V ±0.5 VDC between TP5 and Pin 14 of U8 with E1 jumper installed. NO: Check for continuity to RAM.
2. No countdown at power-up; Display is all 9's.	a. No Microprocessor clock	a1. Check for 4.9152 MHz. NO: Troubleshoot clock circuit.
		a2. Check U5 Pin 19 for 4.9152 MHz. NO: Check continuity.
	b. No real time clock interrupts	b1. Check TP9 for RTCI signal. NO: Go to clocks.
		b2. Check U4 Pin 39 for signal. NO: Check continuity.
	c. Microprocessor in wrong state	c. Check Pins 22, 33, and 40 for +5 VDC. Check Pins 17, 23, and 31 for ± 0.05 VDC.
	d. Failed Micro-processor	d. Run UUT with Fluke simulator. YES: Replace 8088 microprocessor.
	e. Failed EPROM	e. Perform ROM check with Fluke.

Table 5-32. Indicator/Recorder Microprocessor PCBA - CONT

Problem	Probable Cause	Remedy
3. No communication or communication errors	a. Carrier detect latched high	a. Check jumper E5 is in off position
	b. Modem Calibration out G tolerance	b. Run Modem Calibration section of test procedure paragraph 5-10.2.7.
4. CPU Test Failed	Faulty Microprocessor circuit	See Problem #2
5. ROM Test Failed	a. No Vee or Vpp	a. Check Pins 1 and 28 for 5 VDC.
	b. Chip select not enabled	b. Check state of TP17
	c. Failed EPROM	c. Replace EPROM
6. Failed RAM	a. Not receiving correct commands	a. Check states of Pin 27 (WE*), Pin 20 (CS*) and Pin 22 (OE*) of U9. +
	b. Not receiving proper addressing	b. Check U7 outputs
	c. RAM Chip Failure	c. Replace RAM
7. AWDS loop test failure	a. Failed 26LS32	a. Check U3 inputs and outputs
	b. Failed UA9636A	b. Check U13 inputs and outputs
8. Does not increment time correctly	Real Time Clock out of tolerance	Run Real Time clock adjust section G Test Procedure (Paragraph 5-10.2.7.4.3).

+ The letters "WE*", "CS*", "OE*" are signal names of the schematic. The letter pair mean Write Enable, Chip Select, Output Enable, respectively. The "*" character indicates inversion or active low signal.

5-11.3 **Indicator/Recorder Interconnect PCBA.** Refer to FIGURE 27 of the Circuit Diagram Manual (T.O. 31M1-2FMQ13-3) when using table 5-33 for troubleshooting the Indicator/Recorder Interconnect PCBA.

Table 5-33. Indicator/Recorder Interconnect PCBA

Problem	Probable Cause	Remedy
Most Failures	Not configured correctly loss of continuity	Check configuration for proper setup straps. Perform continuity checks between connectors at the proper pins for the circuit in question.

5-11.4 **Sensor Control Assembly.** Refer to FIGURES 3 and 9 of the Circuit Diagram Manual (T.O. 31M1-2FMQ13-3) when using table 5-34 for troubleshooting the Sensor Control Assembly.

Problems with the Control Assembly should be isolated to the Anemometer Assembly or the A and B Microprocessor Assembly. Problems isolated to the A and B Microprocessor Assembly are covered in the next section. The Anemometer Assembly contains the sensing elements, the temperature sensor and the heaters.

Table 5-34. Sensor Control Assembly

Problem	Probable Cause	Remedy
1. Element Driver errors	Damaged element	Visually inspect elements (refer to paragraph 5-7.4.1).
	a. Open heating element	a. Test resistance heating element: Heater 1 - P13-P15 225 - 305 Ohms Heater 2 - P2-P7 450 - 610 Ohms
2. De-icing heaters will not turn on	b. Failed Power Supply circuit on PCBA 6461-1038	b. Troubleshoot Power Supply (see Section 5-11.6).

5-11.5 **Sensor A and B Microprocessor Assembly.** Refer to FIGURES 3, 4, 5, 6, 7, 8, 11 and 13 of the Circuit Diagram Manual (T.O. 31M1-2FMQ13-3) when using table 5-35 for troubleshooting the Sensor A and B Microprocessor Assembly.

Table 5-35. Sensor A and B Microprocessor Assembly

Problem	Probable Cause	Remedy
1. Multiple Resets	Faulty U3 (Micro B) clock driver	Check pins 10 and 11. Pin 11 (RES) determines state of pin 10.
	Faulty U16 (Micro A)	Check output pin 10, check input pin 12, check pin 3 for RC contact.
	Faulty Q7 (Micro A)	Check base, emitter and collector with J1 off.
	Faulty U4 (HC138)	Check pin 10 for state compared to inputs.
	Failed Microprocessor	Replace U2
2. Counter Test failure	Faulty U11 (Micro B)	Check U11 inputs and outputs.
	Faulty U18 (Micro B)	Check inputs of U18 (pins 4 and 5) against pin 6 for proper output.
3. RAM failed	J1 configured incorrectly	Check position of J1 and correct if necessary.
4. RAM failed	Faulty RAM (U1 Micro B)	Perform RAM test using Fluke 9010A.
5. ROM failed	Faulty U1 or U5 of Micro B (Addressing Problems)	Select ROM at address below D000 and check output pin 3. Select ROM at address above E000 and check output pin 3. Learn valid checksums of EPROM for different blocks in a valid environment. Then check on failing unit. This will often lead to the cause directly.
	Failed ROM	Perform checksum on EPROM in a valid environment. Compare against label.
6. Out of range error	Faulty element driver circuit	See element driver failures below.

Table 5-35. Sensor A and B Microprocessor Assembly - CONT

Problem	Probable Cause	Remedy
7. Pressure sensor test failed	Failed IC	Check outputs of op-amps. U2 pin 1 will range (-1V, -5V). U2 pin 7 will range (3V-7V). U1 pin 9 will range (6V-9V).
	Failed transducer	Connect tubing to transducer and vary pressure between 550mb and 1040mb while observing VBARO.
8. A/D test failure	Failed U1 (Micro A)	Check inputs and outputs for proper latching.
	Faulty A/D converter	Check status (pin 27).
		Check if chip is extremely hot (drawing high current).
9. Temp sensor failure	Faulty circuit	Check UREF
	Faulty OP AMP U12 (Micro A)	Check TP1
10. Does not respond to polls	Faulty Comm Circuit	Check ID configuration Check TP6 Check TP5 Check TP4 Check TP3
	Faulty UART	Check TP2 Initialize UART, read G 4001. Perform reads and writes.
	A/D failure	Troubleshooting A/D
	Faulty U3 (Micro A)	Check input and output of inverter.
11. All drives failed	Connections between Micro A and Micro B Faulty	Perform continuity test to all relevant lines.
X drivers fail or 4 drivers fail		

Table 5-35. Sensor A and B Microprocessor Assembly - CONT

Problem	Probable Cause	Remedy
12. Single driver failures		
Driver output out-of-range	Output transistor faulty	Check for shorted emitter to collector
	LT1014 Op-amp faulty	Check output on both sides of R9
	Resistor Network faulty	Check voltages at pins of Resistor pack, check signals at points in question.
	Faulty OP07A Op-amp	Check pin 6 for VREF.
	Faulty LT10BA	Check inputs and outputs for proper ADDING.
Driver output is null	Faulty output transistor	Check for shorted transistor.
	Faulty output transistor	Check for open or fused transistor.
	Circuit failure	Perform same checks as in out-of-range.

5-11.6 **Sensor Power Supply Assembly**. Refer to FIGURES 8, 9, 14 and 15 of the Circuit Diagram Manual (T.O. 31M1-2FMQ13-3) when using table 5-36 for troubleshooting the Sensor Power Supply Assembly.

Table 5-36. Sensor Power Supply Assembly

Problem	Probable Cause	Remedy
1. Loss of +12 and +5 volts	Q5 Faulty	Check TP2 Check TP3 Check U1 pin 15 Check voltage between R8 and R9, should be 7.5V ± 1V. Check voltage pin 12 U1 for close ground replace Q5.
	U1 Faulty	Check U1 pins 11 and 14 for ground check pins 12 and 13. Momentarily short pins 11 and 12 of U1 while monitoring TP3. If voltage jumps to 12V, replace U1.

Table 5-36. Sensor Power Supply Assembly - CONT

Problem	Probable Cause	Remedy
2. Loss of +5 volts +12V present	U4, voltage regulator	Check pin 1 of U4 (VIN). Check pin 2 of U4 (+5 out). Check pin 3 for GND. If VIN is normal and pin 3 is ground, replace U4.
3. Loss of +15V	U5, voltage regulator faulty	Check TP8. Check pin 2 of U5. If TP8 correct, replace U5.
	Diode circuit faulty	Perform diode tests on CR5-CR8.
4. Loss of -15V	U6, voltage regulator faulty	Check TP6 and pin 1 of U6. If correct, replace U6.
	Diode circuit faulty	CR5-CR7 diode checks.
5. Circuit breaker trips on power-up	CR1 or CR2 shorted	Perform diode checks and replace proper diode.
6. No voltage is output at all	AC voltage not present	Check between E12 and E14 for 120VAC.
7. Heaters will not turn on	Q5 faulty	Check base, collector, and emitter while heater circuit turned on.
	U1 faulty	Check pins 4 and 6 of U1.
	CR7 faulty	Check anode and cathodes of CR7.
8. No power out to element drivers	Power transistor faulty	Check correct (Q1-Q4 on power back) base, collector, and emitter with driver turned off, check same with driver on.
9. Communications errors	Modem circuit out of tolerance	Calibrate by test procedure.

Section III. PERFORMANCE TEST CHECKS

5-12 WIND DIRECTION AND SPEED INDICATOR ID-2408/FMQ-13(V) PERFORMANCE TEST.

5-12.1 **Indicator Assembly Performance Test**. The following paragraphs provide acceptance tests which are used to verify satisfactory electrical performance of Wind Direction and Speed Indicator ID-2408/FMQ-13(V) (hereinafter referred to as the indicator).

5-12.2 **Equipment Required But Not Supplied**. Following is a list of test equipment required to accomplish the indicator assembly electrical performance tests.

a. Multimeter, Fluke Model 77, or equivalent.
b. Indicator/Recorder Subassembly Test Set, Sutron P/N 6700-1001, or equivalent.
c. Wind Sensor Simulator Software EPROM, Sutron P/N 8200-1007.
d. AWDS Test Fixture, Sutron P/N 6700-1003.
e. AC Power Cable, Sutron P/N 6411-1011, or equivalent.
f. Indicator Interassembly Cable, Sutron P/N 6411-1066.

5-12.3 **Test Requirements**. The Indicator/Recorder Subassembly Test Set and the Wind Sensor Simulator Software (hereinafter referred to as the sensor simulator) are used to simulate a wind sensor assembly while performing the test procedures of paragraph 5-12.1.4. It simulates the monitoring and processing of wind samples for up to four sensors. In the "REGULAR" mode, it will transmit the 5-second averaged wind speed and direction X and Y data to the indicator when polled by the indicator. The X and Y data is used by the indicator to process actual wind (speed, direction, gust, gust spread, peak wind, and standard deviation). When configured in the MASTER mode, the sensor simulator will transmit the wind data every 5 seconds without an indicator poll request. This allows testing of the indicator in the "REGULAR" mode since the indicator will not initiate the sensor poll request.

5-12.4 **Preliminary**. Prepare the indicator assembly for test by performing the following preliminary procedures:

a. Verify that POWER switch CB1 on the indicator front panel is in the OFF position. Remove chassis cover lid and set aside until later. Remove the microprocessor PCBA.

b. Configure the indicator for two sensors by positioning jumpers E3 ON and E4 OFF on the interconnection PCBA. Refer to strapping table on drawing 6461-1029-1.

c. Place the Battery Backup Enable Jumper E1 in "on" position on the microprocessor PCBA. (Refer to table 5-37). Re-install the microprocessor PCBA.

d. Configure the indicator to the test setup as shown in FIGURE 5-15.

e. Verify that POWER switch CB1 on the indicator/recorder subassembly test fixture is in the OFF position. Install the wind sensor simulator software EPROM into the test fixture's microprocessor PCBA. The indicator/recorder subassembly test fixture will hereinafter be referred to as the sensor simulator.

f. Connect the indicator and sensor simulator to a 115V, 60 Hz power source.

g. Set CONFIGURATION switch S1 on indicator rear panel to MASTER.

Table 5-37. Shipping Position of Jumpers

Jumper	Function	Position	Status	Qty
PCBA 6461-1014 - Microprocessor PCBA				
E1	Battery Enable	on pin 1 only	Disable	1
E4	Watchdog timer	on pins 2 and 3	Enable	1
E5	Carrier ON	on pin 2 only	Disable	1
PCBA 6461-1029 - Interconnect PCBA				
E1	2-MIN/10-MIN	on Pin 1 and 2	2 minute average	1
E3	# of sensors, MSB	on pin 2 only	Set for one sensor	1
E4	# of sensors, LSB	on pin 2 only	Set for one sensor	1
E32	110/220 ACV	on pins 1 and 4 on pins 2 and 3 on pins 5 and 6	110 VAC 110 VAC 110 VAC	3
E33	Comm. Line Termination	on pin 1 only on pin 4 only	600 ohm 600 ohm	2

h. Set INTENSITY control on the indicator front panel to mid position.

i. Set the AWDS test fixture OUTPUT switch to ENABLE position. Turn "on" the AWDS test fixture. Verify that the DATA LED is ON. If not, the internal battery may need replacement.

j. Configure the sensor simulator switches as follows:

S1 - REG
S2 - IND
S3 - 2
S4 - OFF
S5 - ON

k. Turn the sensor simulator power switch CB1 to ON. The following parameters are defaulted by the sensor simulator and will be displayed on the front panel after the displays finish the 9 to 0 count down display test:

Wind Direction - 045
Wind Speed - 020
Active Sensor - 1

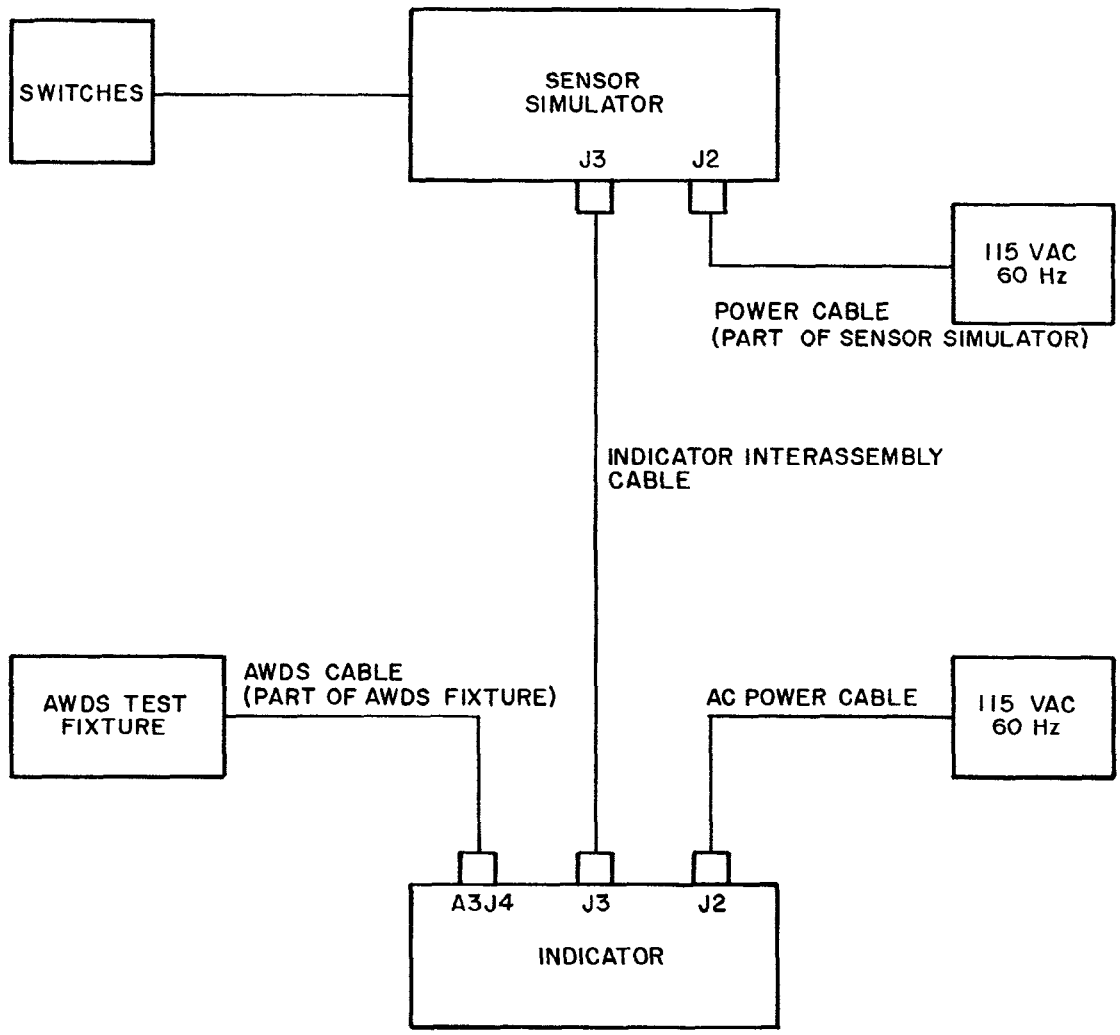


FIGURE 5-15. Test Setup for Indicator Test

5-12.5 **Test Procedures**. Perform the following test procedures in the sequence given.

a. Turn the indicator POWER switch CB1 to ON. Verify that the wind data 7-segment displays will count down from 9 to 0 and then the wind data 7-segment displays will flash.

b. Depress and hold the LAMP TEST button while observing the front panel 7-segment displays. All 7-segment displays should show a number 8.

c. Use a multimeter (set to measure AC) to measure the following AC voltages on the secondary of the power transformer through the transformer shield.

Multimeter Connection		Limits	
+ Lead	- Lead	Min.	Max.
31VAC A	31VAC B	25.0 VAC	34.7 VAC
31VAC A	31VAC CT	12.5 VAC	17.4 VAC
10VAC A	10VAC B	8.0 VAC	11.6 VAC

d. Use a multimeter (set to measure DC voltage) to measure the following DC voltages on the test points at top of the microprocessor PCBA.

Multimeter Connection		Limits	
+ Lead	- Lead	Min.	Max.
A+5V TP1	DGND TP4	4.75 VDC	5.25 VDC
+5V TP5	DGND TP4	4.75 VDC	5.25 VDC
+12V TP3	DGND TP4	11.4 VDC	12.6 VDC
-12V TP16	DGND TP4	-12.6VDC	-11.4VDC

e. Use a multimeter (set to measure DC voltage) to measure the following DC voltage test points on the top of the solder side of the display PCBA.

Multimeter Connection		Limits	
+ Lead	- Lead	Min.	Max.
VLED TP10	GND TP8	6.1 VDC	6.6 VDC

f. Rotate the INTENSITY control to full counterclockwise (ccw) and then to full clockwise (cw) position. Observe the 7-segment displays while at full ccw and cw positions.

Full ccw - All 7-segment displays off
Full cw - All 7-segment displays at maximum brightness

g. Readjust the INTENSITY control for operator's desired brightness. Observe data displayed on the WIND DIRECTION, WIND SPEED, GUSTS, DIRECTION VARIABILITY, GUSTS SPREAD, and ACTIVE SENSOR displays.

Wind Data Displays	Limit
Wind Direction	045 °
Wind Speed	020 knots
Gusts	000 knots
Direction Variability	045 ° to 045 °
Gust Spread	00 knots
Active Sensor	1

h. Depress and hold the ACTIVE SENSOR SELECT button. While holding the ACTIVE SENSOR SELECT button, depress the SENSOR SELECT button 2. Release both buttons and observe the ACTIVE SENSOR display. The ACTIVE SENSOR display should display a number 2.

i. Observe data displayed on the WIND DIRECTION, WIND SPEED, GUSTS, DIRECTION VARIABILITY, and GUST SPREAD displays.

Wind Data Displays	Limit
Wind Direction	045 °
Wind Speed	020 knots
Gusts	000 knots
Direction Variability	045 ° to 045 °
Gust Spread	00 knots

j. Depress SENSOR SELECT button 1. Observe that the SENSOR SELECT 1 LED is on and a number 2 is displayed on the ACTIVE SENSOR display.

k. Depress SENSOR SELECT button 2. Observe that the SENSOR SELECT 2 LED is on and a number 2 is displayed on the ACTIVE SENSOR display.

l. Depress SENSOR SELECT button 3. Observe that the SENSOR SELECT 3 LED is on and a number 2 is displayed on the ACTIVE SENSOR display.

m. Observe the wind data displays. Each 7-segment display of wind data displays should display a number 5.

n. Depress SENSOR SELECT button 4. Observe that the SENSOR SELECT 4 LED is on and a number 2 is displayed on the ACTIVE SENSOR display.

o. Observe the wind data displays. Each 7-segment display of wind data displays a number 5.

p. Depress SENSOR SELECT button 4 again Observe that the SENSOR SELECT 1-4 LEDs are off and a number 2 is displayed on the ACTIVE SENSOR display.

q. Depress the SET/RUN button and observe that the HOURS field of the TIME display flashes.

r. Depress the FIELD SELECT button five times until the YEAR field of the DATE display flashes.

s. Depress the UP button. Observe that the YEAR display value increases by 1.

t. Depress the DOWN button. Observe that the YEAR display value decreases by 1.

u. Depress the SET/RUN button. Observe that the TIME and DATE displays are not flashing.

v. Observe that the DATA LED on the AWDS test fixture connected to AWDS A3J4 connector flashes on and off every 5 seconds.

w. Set the OUTPUT switch on the AWDS test fixture to DISABLE position. Observe that the DATA LED on the AWDS test fixture is on steady.

x. Observe that a flashing number 04 is displayed on the indicator STATUS display.

y. Depress the STATUS CLEAR button and observe that a constant number 04 is displayed on the indicator STATUS display.

z. Record the time displayed on the TIME display.

aa. Set the indicator POWER switch CB1 to OFF, and set the indicator CONFIGURATION switch S1 to BACKUP.

ab. Set the indicator POWER switch CB1 to ON. Wait until display finishes count down and then observe the TIME display. Verify that time was not lost during power-down.

ac. Wait at least 20 seconds after turning power on, then observe that a flashing number 46 is displayed on the STATUS display.

ad. Depress the STATUS CLEAR button and wait at least 5 seconds. Observe that a constant number 44 is displayed on the STATUS display.

ae. Set the indicator POWER switch to OFF. Set the indicator CONFIGURATION switch S1 to REGULAR.

af. Set the sensor simulator POWER switch CB1 to OFF. Set the sensor simulator rear panel switch S1 to the MASTER position.

ag. Turn the sensor simulator POWER switch CB1 to ON. The following parameters are defaulted by the sensor simulator and are displayed on the front panel:

Wind Direction - 045
Wind Speed - 020
Active Sensor - 1

ah. Set the indicator POWER switch CB1 to ON. Wait 10 seconds after turning power on and depress the STATUS CLEAR button. Wait 10 seconds and then observe that a constant number 04 is displayed on the STATUS display.

ai. Disconnect the indicator interassembly cable from the rear Inter-Assembly Communication J3 connector.

aj. Wait 10 seconds after removing the cable and observe that a flashing number 06 is displayed on the STATUS display.

ak. Turn the indicator POWER switch CB1 to OFF. Reconfigure the jumpers on both the interconnection PCBA and the microprocessor PCBA according to table 5-37.

al. Install the chassis cover lid on the indicator.

5-13 WIND DIRECTION AND SPEED RECORDER RO-588/FMQ-13(V) PERFORMANCE TEST.

5-13.1 **Recorder Assembly Performance Test**. The following paragraphs provide acceptance tests which are used to verify satisfactory electrical performance of the Wind Direction and Speed Recorder RO-588/FMQ-13(V) (hereinafter referred to as the recorder).

5-13.2 **Equipment Required But Not Supplied**. Following is a list of test equipment required to accomplish the electrical performance tests.

a. Multimeter, Fluke Model 77, or equivalent.
b. Indicator/Recorder Sub-Assembly Test Set, Sutron P/N 6700-1001, or equivalent.
c. Wind Sensor Simulator Software EPROM, Sutron P/N 8200-1007.
d. AWDS test fixture, Sutron P/N 6700-1003.
e. AC power cable, Sutron P/N 6411-1011, or equivalent.
f. Indicator Interassembly cable, Sutron P/N 6411-1066.
g. Computer paper, 9 1/2 X 11 with tractor feed perforated edges.

5-13.3 **Test Requirements**.

a. Tests are conducted at ambient temperature and humidity.

b. The Indicator/Recorder Sub-Assembly Test Set and the Wind Sensor Simulator Software (hereafter referred to as the sensor simulator) are used to simulate a standard sensor assembly while performing the detail test procedures of section 5-13.5. It simulates the monitoring and processing of wind samples for up to 4 sensors. In the "REGULAR" mode, it will transmit the five-second average wind speed and direction X and Y data to the recorder when polled by a recorder. The X and Y data is used by the recorder to process actual wind data (speed, direction, gust, gust spread, peak wind, and standard deviation). When configured in the "MASTER" mode, the sensor simulator will transmit the wind data every five seconds without a recorder poll request. This allows testing of the recorder when in the "REGULAR" mode since the recorder will not initiate the sensor poll request.

5-13.4 **Preliminary**. Perform the following preliminary procedures.

a. Verify that the POWER switch CB1 on the recorder front panel is in the OFF position. Remove chassis cover lid and set aside till later. Remove the microprocessor PCBA.

b. Configure recorder for 2 sensors by positioning jumpers E3 ON and E4 OFF on interconnection PCBA.

c. Place the Battery Backup Enable Jumper E1 in the "on" position on the microprocessor board. Replace the microprocessor.

d. Configure the recorder to the test setup as shown in FIGURE 5-16. Note that recorder's printer is to be tested out of the printer chassis to ease testing.

e. Verify that the POWER switch CB1 of the Indicator/Recorder Sub-Assembly test fixture is in the "OFF" position. Install the wind sensor simulator software EPROM into test fixture's microprocessor PCBA. The Indicator/Recorder Sub-Assembly test fixture will hereinafter be referred as the sensor simulator.

f. Connect the recorder and sensor simulator to a 115V, 60Hz power source.

g. Set the CONFIGURATION switch S1 on recorder rear panel to MASTER.

h. Set the INTENSITY control on recorder front panel to mid position.

i. Install paper into the printer.

j. Set the AWDS test fixture "output" switch to "ENABLE" position. Turn "on" the AWDS test fixture. Verify that the "DATA" LED is ON. If not, the internal battery may need replacement.

k. Configure the sensor simulator switches as follows:

S1 - REG
S2 - REC
S3 - 2
S4 - OFF
S5 - ON

l. Turn the sensor simulator power switch CB1 to ON. The following parameters are defaulted by the sensor simulator and will be displayed on the front panel after the displays finish the 9 to 0 count down display test:

Wind Direction - 045
Wind Speed - 020
Active Sensor - 1

5-13.5 **Test Procedures**. Perform the following test procedures in the sequence given.

a. Turn the recorder POWER switch CB1 to ON. Verify that the wind data 7-segment displays will count down from 9 to 0 and that the wind data 7-segment displays are flashing.

b. Depress and hold the LAMP TEST button while observing the front panel 7-segment displays.

c. Use a multimeter (set to measure AC) to measure the following AC voltages on the secondary of the power transformer through the transformer shield.

Multimeter Connection		Limits	
+ Lead	-Lead	Min.	Max.
31 VAC A	31 VAC B	25.0 VAC	47.0 VAC
31 VAC A	31 VAC CT	12.5 VAC	17.4 VAC
10 VAC A	10 VAC B	8.0 VAC	11.6 VAC

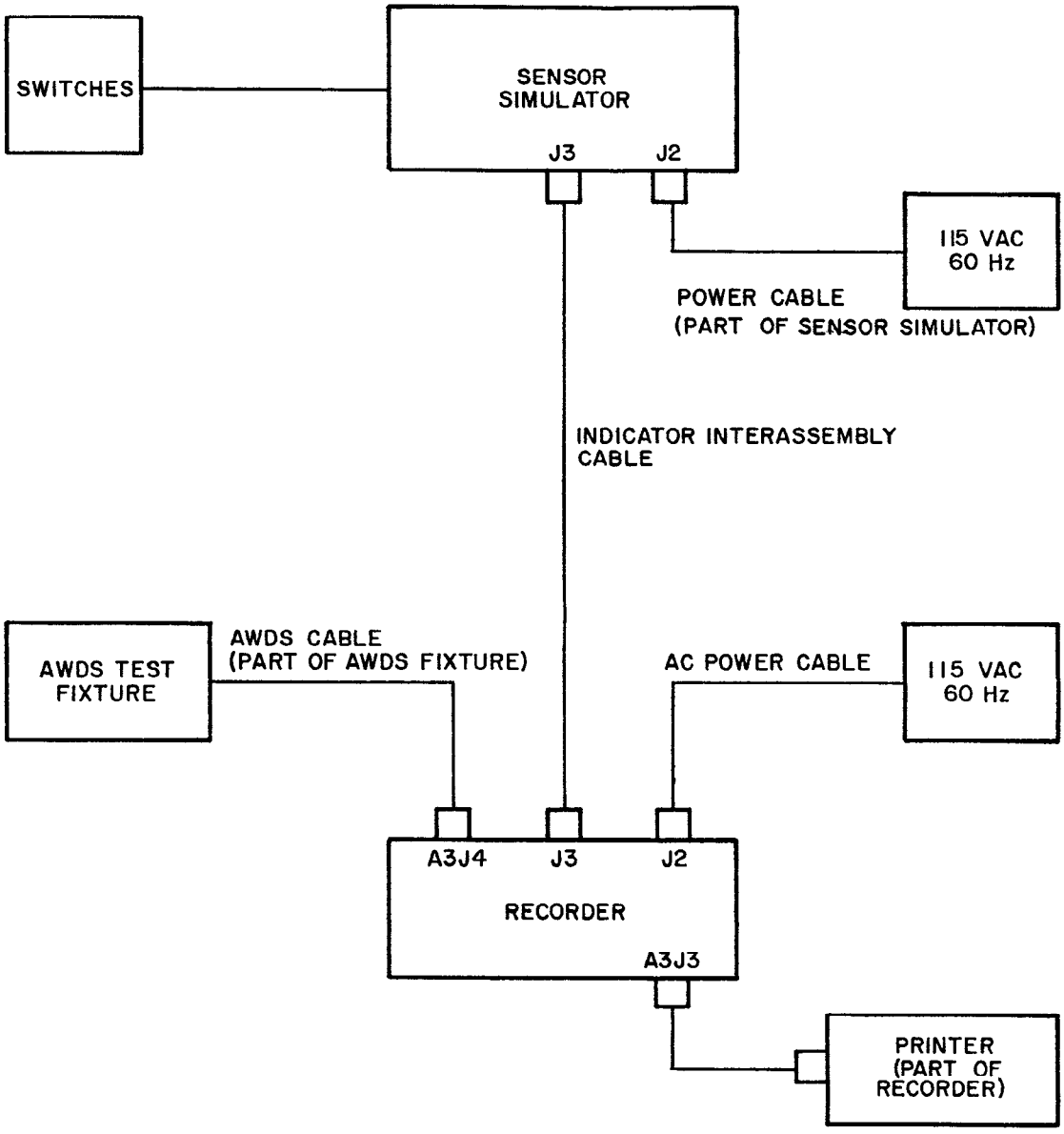


FIGURE 5-16. Test Setup for Recorder Test

d. Use a multimeter (set to measure DC voltage) to measure the following DC voltages on the test points at top of the microprocessor board.

Multimeter Connection		Limits	
+ Lead	-Lead	Min.	Max.
A+5V TP1	DGND TP4	4.75 VDC	5.25 VDC
+5V TP5	DGND TP4	4.75 VDC	5.25 VDC
+12V TP3	DGND TP4	11.40 VDC	12.60 VDC
-12V TP16	DGND TP4	-11.40 VDC	12.60 VDC

e. Use a multimeter (set to measure DC voltage) to measure the following DC voltage test points on the top of the solder side of the display board.

Multimeter Connection		Limits	
+ Lead	-Lead	Min.	Max.
VLED TP10	GND TP8	6.1 Volts	6.6 Volts

f. Rotate the INTENSITY control to full counterclockwise (ccw) and then to full clockwise (cw) position. Observe the 7-segment displays while at full ccw and cw positions.

g. Readjust the INTENSITY control for operator's desired brightness. Observe data displayed on the WIND DIRECTION, WIND SPEED, GUSTS, DIRECTION VARIABILITY, GUSTS SPREAD, and ACTIVE SENSOR displays.

h. Observe the printer's printout. Verify that the printout of the DATE, TIME, DIRECTION, SPEED, GUST, DIRECTION VARIABILITY, GUST SPREAD, ACTIVE SENSOR, and STATUS match the values on the display.

i. Depress DISPLAY SELECT PW-10 button. Observe that DISPLAY SELECT PW-10 LED is ON and GUSTS/PW TYPE display is 010.

j. Observe the printer's printout. Verify that the printout of the 10 MINUTE PEAK WIND'S DIRECTION, SPEED, AND TIME OF OCCURRENCE and STANDARD DEVIATION (SD) match the values on the display.

k. Depress DISPLAY SELECT PW-60 pushbutton. Observe that DISPLAY SELECT PW-60 LED is ON and GUSTS/PW TYPE display is 060.

l. Observe the printer's printout. Verify that the printout of the 60 MINUTE PEAK WIND'S DIRECTION, SPEED, AND TIME OF OCCURRENCE match the values on the display.

m. Depress DISPLAY SELECT PW-24 pushbutton. Observe that DISPLAY SELECT PW-24 LED is ON and GUSTS/PW TYPE display is 024.

n. Observe the printer's printout. Verify that the printout of the 24 HOUR WIND'S DIRECTION, SPEED, AND TIME OF OCCURRENCE match the values on the display.

o. Depress DISPLAY SELECT NORMAL button. Observe that DISPLAY SELECT NORMAL LED is ON.

p. Depress the SET/RUN button and observe the TIME display. The HOURS 7-segment displays will flash.

q. Depress the FIELD SELECT button until the YEAR field of the DATE display flashes.

r. Depress the UP button. Observe that YEAR field increases.

s. Depress the DOWN button. Observe that YEAR field decreases.

t. Depress the SET/RUN button. Observe that the TIME and DATE displays return to normal.

u. Observe that the DATA LED on the AWDS test fixture connected to AWDS A3J4 connector flashes approximately every 5 seconds.

v. Set the output switch on the AWDS test fixture to "DISABLE" position. Observe that the DATA LED on the AWDS test fixture is on continuously.

w. Observe that the number on the recorder STATUS display flashes 04.

x. Depress the STATUS CLEAR button and observe that the STATUS display will display a constant 04.

y. Note the time displayed on the TIME display for use in step aa.

z. Set the recorder POWER switch CB1 to OFF, and set the recorder CONFIGURATION switch S1 to BACKUP.

aa. Set the recorder POWER switch CB1 to ON. Wait until display finishes countdown and observe the TIME display. Verify time was not lost during power-down.

ab. Wait at least 20 seconds after turning power on, then observe that the STATUS display will indicate a flashing 46.

ac. Depress the STATUS CLEAR button and wait at least 5 seconds. Observe that the STATUS display is a constant 44.

ad. Set the recorder POWER switch CB1 to OFF. Set the recorder CONFIGURATION switch S1 to REGULAR.

ae. Set the sensor simulator POWER switch CB1 to OFF. Set the sensor simulator panel switch S1 to the "MAS" position.

af. Turn the sensor simulator POWER switch CB1 to ON. The following parameters are defaulted by the sensor simulator and are displayed on the front panel:

Wind Direction - 045 °
Wind Speed - 020 knots
Active Sensor - 1

ag. Set the recorder POWER switch CB1 to ON. Wait 20 seconds after turning power on and depress the STATUS CLEAR button. Wait 10 seconds and then observe that the recorder STATUS display is a constant 04.

ah. Disconnect the Indicator Interassembly cable from the rear Inter-Assembly Communication.

ai. Wait 10 seconds after removing the cable and observe the STATUS display. A flashing 06 will be displayed.

aj. Depress the STATUS CLEAR button and then depress the printer SELECT button to put the printer off line. Wait 5 seconds and then observe the STATUS display. A flashing 07 will be displayed.

ak. Depress the printer SELECT button to put the printer back on line. Depress the STATUS CLEAR button. Wait 5 seconds and observe the STATUS display. A constant 06 will be displayed.

al. Reconnect the sensor simulator to the rear J3 connector and wait 10 seconds. While depressing and holding the sensor simulator ACTIVE SENSOR SELECT button, depress the SENSOR SELECT 2 button on the sensor simulator. Observe that the ACTIVE SENSOR display on the sensor simulator is displaying a "2". Repeat the buttons depression if necessary. Observe that Recorder ACTIVE SENSOR displays a "2" and alarm is audible.

am. Depress the recorder ALARM RESET button and observe that the alarm is no longer audible.

an. Turn the recorder power switch CB1 to off. Reconfigure the jumpers on both the interconnection PCBA and the microprocessor PCBA to their original "shipping" position per table 5-37.

ao. Install the chassis cover lid on the recorder.

5-14 WIND DIRECTION AND SPEED SENSOR ML-660/FMQ-13(V) PERFORMANCE TEST.

5-14.1 **Purpose.** This section provides acceptance tests which are used to verify satisfactory electrical performance of the Wind Direction and Speed Sensor ML-660/FMQ-13(V) (hereafter referred to as the sensor).

5-14.2 **Equipment Required But Not Supplied.** The following is a list of test equipment required to accomplish the electrical performance tests.

a. Multimeter, Fluke Model 77 or equivalent.
b. Indicator/Recorder Sub-Assembly test set, Sutron P/N 6700-1001.
c. Indicator Simulator Software EPROM, Sutron P/N 8200-1006.
d. AC power cord, Beldin P/N 17512C or equivalent.
e. Sensor Interassembly cable, Sutron P/N 6411-1067 or equivalent.
f. Static Sensor assembly, Sutron P/N 6661-1019 or equivalent.

5-14.3 **Test Requirements.**

a. Tests are conducted at room ambient temperature and humidity.

b. The Indicator/Recorder Sub-Assembly test set and the Indicator Simulation Software (hereinafter referred to as the indicator) are used to poll and read wind data from the sensor while performing the detailed test procedures of Section 5-14.5. The sensor's five-second average wind speed and direction X and Y data and its status are continuously polled, processed, and displayed every five seconds by the indicator.

5-14.4 **Preliminary.** Perform the following preliminary procedures:

a. Verify that the circuit breaker CB1 on the sensor assembly is in the OFF position.

b. Position links J5 and J6 on Microprocessor A PCBA as sensor ID#1. (Both jumpers on pin 1 and 2.)

c. Configure the sensor to the test setup as shown in FIGURE 5-17.

d. Verify that the power switch CB1 of the Indicator/Recorder Sub-Assembly test fixture is in the "OFF" position. Install the indicator simulator software EPROM into the test fixture's microprocessor PCBA. The Indicator/Recorder Sub-Assembly test fixture will hereinafter be referred to as the indicator simulator.

e. Connect the sensor and indicator simulator to a 115V, 60Hz power source.

f. Set the INTENSITY control on the indicator's front panel to mid position.

g. Configure the indicator simulator switches as follows:

S1 - MAS
S2 - IND
S3 - 2
S4 - OFF
S5 - OFF

h. Turn the indicator simulator power switch CB1 to ON. The 7-segment displays should display a count down of 9 to 0. Upon completion of count down, verify that the STATUS display is flashing a number 02. If the number displayed is not 02, then do not continue with this test procedure. Refer to Test Set repair manual/procedure.

5-14.5 **Test Procedures.** Perform the following test procedures in the sequence given.

a. Turn the main circuit breaker CB1 of the sensor to ON.

b. Use a multimeter (set to measure AC) to measure AC voltages on the secondary of power transformer T1.

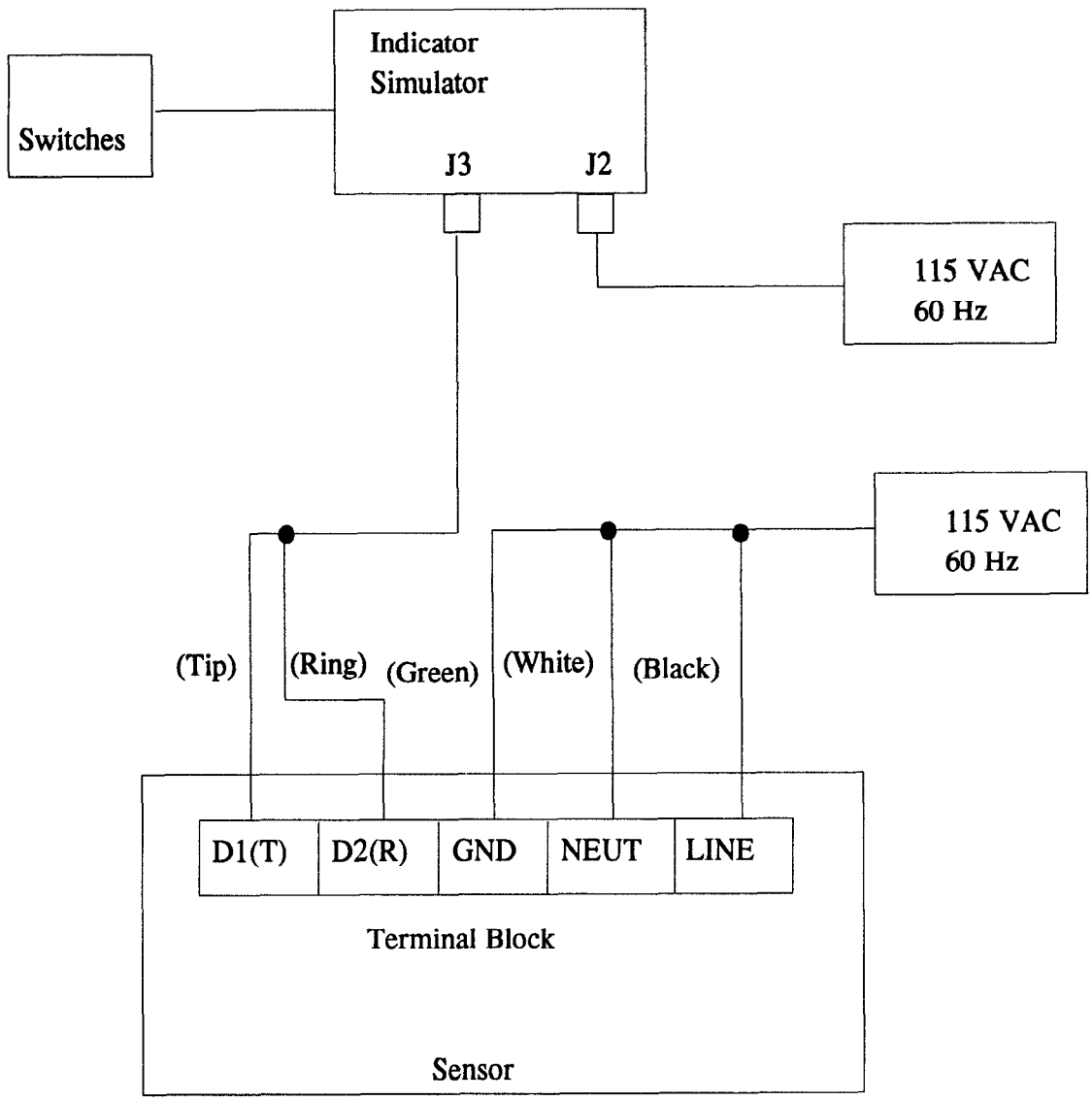


FIGURE 5-17. Test Setup for Sensor Test

Multimeter Connection		Limits	
+Lead	-Lead	Min.	Max.
TAB 7	TAB 8	16.2 VAC	23.4 VAC
TAB 11	TAB 12	16.2 VAC	23.4 VAC

c. Use a multimeter (set to measure DC) to measure DC voltages on the top power supply board test points.

Multimeter Connection		Limits	
+Lead	-Lead	Min.	Max.
+5V TP4	GND TP7	4.75 VDC	5.25 VDC
+15V TP9	GND TP7	14.25 VDC	15.75 VDC
-15V TP5	GND TP7	-15.75 VDC	-14.25 VDC

d. Depress the STATUS CLEAR button on the indicator simulator and wait at least 5 seconds. Observe the indicator status display.

e. Install the static sensor assembly on the sensor.

f. Wait 20 seconds and observe the wind direction and speed on the indicator simulator display.

g. Remove the static sensor assembly from the sensor.

h. Turn off the indicator.

i. Turn off the sensor.

5-14.6 **Sensor Assembly Calibration Test**. This section provides the acceptance test procedure to verify satisfactory direction and speed calibration performance of the Wind Direction and Speed Sensor ML-660/FMQ-13(V).

5-14.6.1 **Equipment Required But Not Supplied**. The following is a list of test equipment required to accomplish the calibrated test.

a. Wind Sensor Characterization/Calibration test set, Sutron P/N 6700-1013.
b. Wind Sensor Calibration Program software disk, Sutron P/N 8202-1011.
c. Wind Sensor Interconnection cable assembly, Sutron P/N 6411-1081.

5-14.6.2 **Test Requirements.**

a. Tests are conducted at room ambient temperature.

b. Test data shall be recorded by the Wind Sensor Characterization/Calibration test set computer and printed at the completion of the test.

c. The Wind Sensor Characterization/Calibration test set is used to measure the accuracy of the wind sensor at the prescribed wind speeds and direction. Table 5-38 lists the speeds and directions for the sensor. The listed speeds and directions are the nominal points, where data will be taken in a calibrated wind tunnel. The actual tunnel speed will be within ± 1 knot of the nominal from 0 to 99 knots. The computer in the test set (see FIGURE 5-18) controls the wind tunnel's speed and direction. After achieving the nominal test point, the computer polls the sensor for its measured wind velocity and direction. The computer prints the data collected at each point. At the end of the test the root mean squared error is computed and tested according to the following table:

Actual Wind Speed	Required Sensor Accuracy
0-50 knots	1 knot
50-75 knots	5% of wind speed
75-99 knots	10% of wind speed

Actual Angle Setting	Required Sensor Accuracy
0-360°	3°

The computer prints the results of the test and whether the sensor passed or failed the test.

5-14.6.3 **Preliminary.** Refer to FIGURE 5-18 for the following preliminary setup procedures.

a. Verify that the AC power cord in the sensor is disconnected from the AC power source.

b. Verify that the sensor circuit breaker CB1 is in the OFF position.

c. Open the cover lid to the sensor assembly. Verify that the links J5 and J6 on Microprocessor-A PCBA is configured as sensor ID #1. (Both jumpers on pins 1 and 2.) Route the Wind Sensor Interconnection cable assembly through the sensor's bottom mounting support and attach the cable to the sensor terminal block as shown in FIGURE 5-18. Close and tighten sensor lid cover.

d. Open the wind tunnel test section door and remove both test section floor plates.

e. Connect the Wind Sensor Interconnection cable assembly to the connector of the cable assembly extending from top of the Sensor Mounting Stub.

f. Slip the top of sensor assembly into the wind tunnel test section through the opening in the test section floor. Then slip the bottom sensor support pipe onto the Sensor Mounting Stub. Ensure that the notch of the sensor support pipe is resting firmly around the pin protruding from the Sensor Mounting Stub. Tighten the sensor assembly U-bolt securely.

g. Secure both wind tunnel section floor plates around the sensor assembly. Close the test section door.

h. Note the position of the sensor on the rotary turntable. Move sensor to nearest degree by turning adjustment knob on front of the rotary turntable.

Table 5-38. Calibration Test (Standard Sensor)

WIND DIRECTION AND SPEED SENSOR (STANDARD)			
TUNNEL VELOCITY		TUNNEL VELOCITY	
Speed	Direction	Speed	Direction
0	0	95	350
5	0	95	340
10	10	90	330
15	20	90	320
15	30	85	310
20	40	85	300
20	50	80	290
25	60	80	280
25	70	75	270
30	80	75	260
30	90	70	250
35	100	70	240
35	110	65	230
40	120	65	220
40	130	60	210
45	140	60	200
45	150	55	190
50	160	55	180
50	170	50	170
55	180	50	160
55	190	45	150
60	200	45	140
60	210	40	130
65	220	40	120
65	230	35	110
70	240	35	100
70	250	30	90
75	260	30	80
75	270	25	70
80	280	25	60
80	290	20	50
85	300	20	40
85	310	15	30
90	320	15	20
90	330	10	10
95	340	5	0
95	350	0	0
99	360		

i. Apply AC power to the sensor and turn the sensor circuit breaker CB1 to the ON position.

j. Turn the computer on or if already on, press the ALTERNATE, CONTROL, and DELETE keys simultaneously to make the computer re-boot. Once the computer has completed the boot procedure, type the command:

CALSTD

This command will tell the computer to change directories to the area of memory where the program and associated files reside and begin execution of the appropriate program. The user will be prompted to perform certain tasks and the computer will conduct a System Calibration Check. The program will then display the main menu as follows:

SUTRON WIND SENSOR TEST PROGRAM

1) COMPUTER CONTROLLED.....TRUE, AC MOTOR

2) DATE.....06-09-1987

3) SENSOR ID#.....

4) TYPE OF TEST.....CALIBRATION TEST
standard sensor

5) TABLE POSITION.....0

6) FILE NAME .....

7) OPERATOR .....

H FOR HELP TO SETUP HARDWARE
R TO RUN PROGRAM .....
Q TO QUIT
E TO EDIT FILE.DAT.....

RELATIVE HUMIDITY
44.7%

BAROMETRIC PRESSURE
998.39 mB

TEMPERATURE
22.66 deg C

k. To enter the Sensor ID#, which is the serial number for the control assembly, the operator should enter "3" next to the question mark. At this time, the control assembly serial number should be entered as a 5 character code.

NOTE

The control assembly serial number is located on the mounting plate used to join the A-B microprocessor assembly and the anemometer. (See FIGURE 5- 20.)

l. The operator should verify that the position of the test set turntable is at 0 degrees. If the rotary table is not at 0 degrees, enter "5" on the main menu to change the position of the rotary table. For example, if the table position is at 35 degrees, the following instructions will move the sensor to 0 degrees. After "5" has been entered, the following prompt will appear:

ENTER 1..... TO ROTATE TABLE A FRACTION OF A DEGREE
ENTER 2..... TO SET UP POSITION OF TABLE

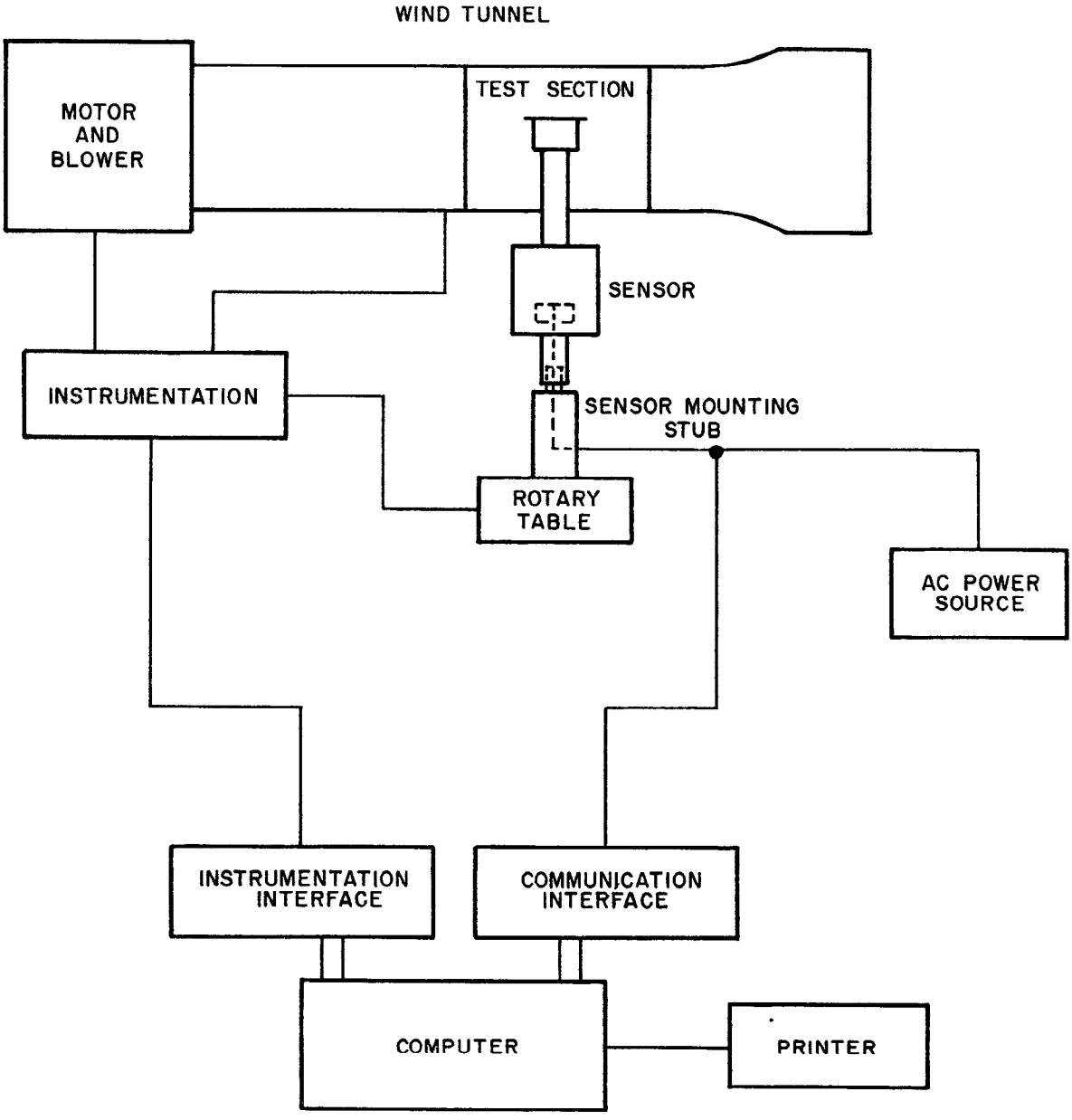


FIGURE 5-18. Wind Sensor Characterization/Calibration Test Set

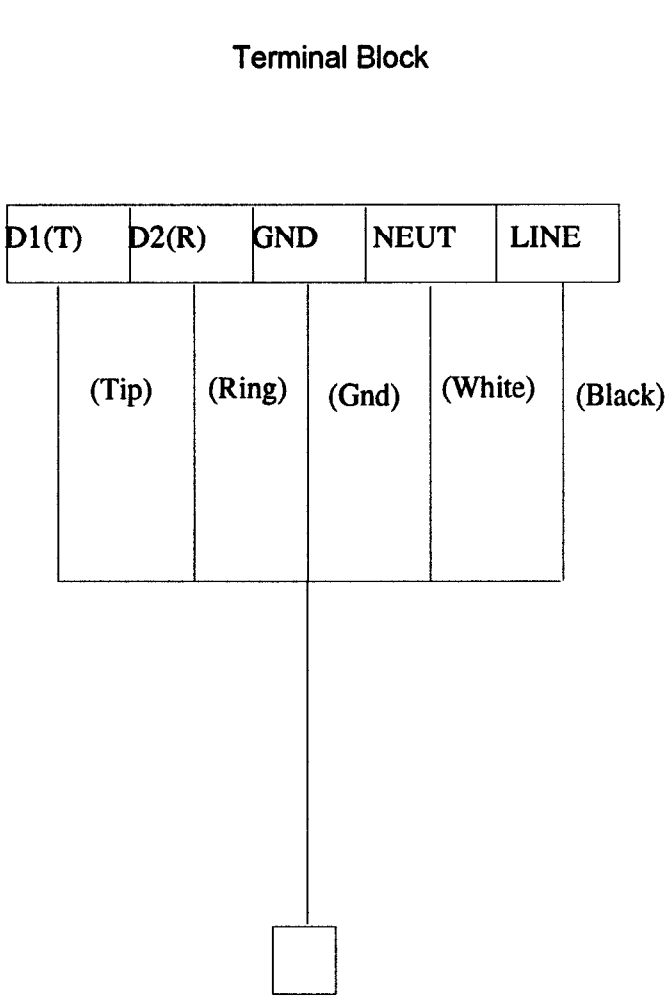


FIGURE 5-19. Wind Sensor Terminal Block Connection

The operator should enter "2" to correct the sensor position. The next prompt is:

ENTER SENSOR POSITION ?

The operator would respond the current sensor position or, for our example, the response would be "35". The next prompt tells the computer how far to rotate the table position.

ENTER DEGREES TO ROTATE TABLE

POSITIVE VALUE FOR COUNTERCLOCKWISE
NEGATIVE VALUE FOR CLOCKWISE

The operator would respond "-35" or "325" depending on which way the table should rotate. This option is given to prevent wrapping sensor wires around the sensor stand as the sensor rotates.

The operator should then enter "7" to change the seventh parameter. This will allow the operator to enter his or her name into the program.

5-14.6.4 **Test Procedures.**

a. The operator should enter "R" to run the test at this point. The program will begin execution at this point and the wind tunnel sensors data will be displayed as current information as shown below:

SUTRON WIND TUNNEL TEST PROGRAM

SENSOR POSITION..... 0 TEMPERATURE.....22.36 C

ATMOSPHERIC PRESSURE = 1009.72 mB 757.35 mmHg.....29.82 Hg

DIFFERENTIAL PRESSURE .000 "H20 .000 "Benzene..... .00 m Benzene

Wind Speed in Knots = 0

SPEED = 0 DIRECTION = 0

GAIN 1 reading : .06713867185
GAIN 2 reading : .06579589375
GAIN 10 reading : .0658691435

***** NOT WRITING TO FILE *****

** ENTER S .. TO BEGIN TEST or TO RETURN TO MENU **

b. The information will be refreshed every couple of seconds to reflect current readings. If the data displayed is valid, then the operator should enter "S" to gain control of the program. A prompt will appear:

ENTER Q -- TO QUIT or ENTER R -- TO RUN ?

Responding with "Q" will cause the program to return the parameter input menu while responding with "R" will cause the program to continue execution.

c. The user will be prompted to enter the sensor serial number. This is the serial number found on the sensor chassis. If the test is being conducted as a subassembly test of the control assembly, enter five spaces with double quotations (i.e. " ").

d. The user will be prompted to install the zero cap over the top of the sensor if the test set computer determines it is necessary.

e. After the test set takes the first test point, the user will be prompted to remove the zero cap from the sensor.

f. The test will now run to completion, displaying values on the computer screen, logging results to a file.

NOTE

If the test needs to be stopped for any reason, holding the CONTROL key down and entering "Q" (CONTROL-Q) will cause the parameter input menu to be displayed.

g. The user will be prompted to install the zero cap over the top of the sensor if the test set computer determines it is necessary.

h. After the test set takes the last test point, the user will be prompted to remove the zero cap from the sensor.

i. When the calibration test is completed, the user will be prompted to check that the printer is ON LINE and at the top of the page. Verify and hit return.

j. Remove the printer printout and attach it to the Data Test sheet. The PASS/FAIL test results will be printed at the bottom of the printout.

k. Turn the sensor circuit breaker CB1 off and remove the AC power from the sensor.

l. Remove the sensor from the Sensor Mounting Stub by reversing the procedures performed in paragraph 5-14.6.3.

m. Open the sensor cover lid and disconnect the Wind Sensor Interconnection cable from the wind sensor terminal block.

n. Ensure that the screws on terminal block are tight and will not work loose during transport. Close and tighten the sensor cover lid.

5-15 RUGGEDIZED WIND DIRECTION AND SPEED SENSOR ML-660A/FMQ-13(V) PERFORMANCE TEST.

5-15.1 **Purpose**. This section provides acceptance tests which are used to verify satisfactory electrical performance of the Ruggedized Wind Direction and Speed Sensor (hereafter referred to as the sensor).

5-15.2 **Equipment Required But Not Supplied**. The following is a list of test equipment required to accomplish the electrical performance tests.

a. Multimeter, Fluke Model 77 or equivalent.

b. Indicator/Recorder Sub-Assembly test set, Sutron P/N 6700-1001.

c. Indicator Simulator Software EPROM, Sutron P/N 8200-1006.

d. AC power cord, Beldin P/N 17512C or equivalent.

e. Sensor Interassembly cable, Sutron P/N 6411-1067.

f. Static Sensor assembly, Sutron P/N 6661-1019.

5-15.3 **Test Requirements**.

a. Tests are conducted at room ambient temperature and humidity.

b. Test Data shall be recorded on the Test Data sheets.

c. The Indicator/Recorder Sub-Assembly test set and the Indicator Simulation Software (hereinafter referred to as the indicator) are used to poll and read wind data from the sensor while performing the detailed test procedures of Section 5-15.5. The sensor's five-second average wind speed and direction X and Y data and its status are continuously polled, processed, and displayed every five seconds by the indicator.

5-15.4 **Preliminary**.

a. Verify that the circuit breaker CB1 on the sensor assembly is in the OFF position.

b. Position links J5 and J6 on Microprocessor A PCBA as sensor ID #1. (Both jumpers on pins 1 and 2.)

c. Configure the sensor to the test setup as shown in FIGURE 5-17.

d. Verify that the POWER switch CB1 of the Indicator/Recorder Sub-Assembly test fixture is in the "OFF" position. Install the indicator simulator software EPROM into the test fixture's microprocessor PCBA. The Indicator/Recorder Sub-Assembly test fixture will hereinafter be referred to as the indicator simulator.

e. Connect the sensor and indicator simulator to a 115V, 60Hz power source.

f. Set the INTENSITY control on the indicator simulator's front panel to mid position.

g. Configure the indicator simulator switches as follows:

S1 - MAS
S2 - IND
S3 - 2
S4 - OFF
S5 - OFF

h. Turn the indicator power switch CB1 to ON. The 7-segment displays should display a count down of 9 to 0. Upon completion of count down, verify that the STATUS display is flashing a number 02. If the number displayed is not 02, then do not continue with this test procedure. Refer to T.O. (TBD) for appropriate troubleshooting procedures.

5-15.5 **Test Procedures**. Perform the following test procedures in the sequence given. Record all data on the Test Data sheet as instructed in the procedure.

a. Turn the main circuit breaker CB1 of the sensor to ON.

b. Use a multimeter (set to measure AC) to measure AC voltages on the secondary of power transformer T1. Record on Test Data sheet.

Multimeter Connection		Limits	
+Lead	-Lead	Min.	Max.
TAB 7	TAB 8	16.2 VAC	23.4 VAC
TAB 11	TAB 12	16.2 VAC	23.4 VAC

c. Use a multimeter (set to measure DC) to measure DC voltages on the top power supply board test points. Record on Test Data sheet.

Multimeter Connection		Limits	
+Lead	-Lead	Min.	Max.
+5V TP4	GND TP7	4.75 VDC	5.25 VDC
+15V TP9	GND TP7	14.25 VDC	15.75 VDC
-15V TP5	GND TP7	-15.75 VDC	-14.25 VDC

d. Depress the STATUS CLEAR button on the indicator simulator and wait at least 5 seconds. Observe the indicator status display. Record on Test Data sheet.

e. Install the static sensor assembly on the sensor.

f. Wait 20 seconds and observe the wind direction and speed on the indicator simulator display. Record on Test Data sheet.

g. Remove the static sensor assembly from the sensor.

h. Turn off the indicator.

i. Turn off the sensor.

5-15.6 **Sensor Assembly Calibration Test**. This section provides the acceptance test procedure to verify satisfactory direction and speed calibration performance of the Wind Direction and Speed Sensor ML-660A/FMQ-13(V).

5-15.6.1 **Equipment Required But Not Supplied**. The following is a list of test equipment required to accomplish the calibrated test.

a. Wind Sensor Characterization/Calibration test set, Sutron P/N 6700-1013.
b. Wind Sensor Calibration Program software disk, Sutron P/N 8202-1011.
c. Wind Sensor Interconnection cable assembly, Sutron P/N 6411-1081.

5-15.6.2 **Test Requirements**.

a. Tests are conducted at room ambient temperature.

b. Test data shall be recorded by Wind Sensor Characterization/Calibration test set computer and attached to the Test Data sheet.

c. The Wind Sensor Characterization/Calibration test set is used to measure the accuracy of the wind sensor at the prescribed wind speeds and direction. Table 5-39 lists the speeds and directions for the sensor. The listed speeds and directions are the nominal points, where data will be taken in a calibrated wind tunnel. The actual tunnel speed will be within ±1 knot of the nominal from 0 to 99 knots. The computer in the test set (see FIGURE 5-18) controls the wind tunnel's speed and direction. After achieving the nominal test point, the computer polls the sensor for its measured wind velocity and direction. The computer prints the data collected at each point. At the end of the test the root mean squared error is computed and tested according to the following table:

Actual Wind Speed	Required Sensor Accuracy
0 - 50 knots	1 knot
50 - 75 knots	5% of wind speed
75 - 99 knots	10% of wind speed
99 - 150 knots	15% of wind speed

Actual Angle Setting	Required Sensor Accuracy
0 - 360°	3°

The computer prints the results of the test and whether the sensor passed or failed the test.

5-15.6.3 **Preliminary.** Refer to FIGURE 5-18 for the following preliminary setup procedures.

a. Verify that the AC power cord in the sensor is disconnected from the AC power source.

b. Verify that the sensor circuit breaker CB1 is in the OFF position.

Table 5-39. Calibration Test (Ruggedized Sensor)

WIND SPPED AND DIRECTION SENSOR (RUGGEDIZED)			
TUNNEL VELOCITY		TUNNEL VELOCITY	
Speed	Direction	Speed	Direction
0	0	145	350
5	0	140	340
10	10	140	330
15	20	135	320
20	30	130	310
20	40	125	300
25	50	120	290
30	60	120	280
35	70	115	270
40	80	110	260
40	90	105	250
45	100	100	240
50	110	100	230
55	120	95	220
60	130	90	210
60	140	85	200
65	150	80	190
70	160	80	180
75	170	75	170
80	180	70	160
80	190	65	150
85	200	60	140
90	210	60	130
95	220	55	120
100	230	50	110
100	240	45	100
105	250	40	90
110	260	40	80
115	270	35	70
120	280	30	60
120	290	25	50
125	300	20	40
130	310	20	30
135	320	15	20
140	330	10	10
140	340	5	0
145	350	0	0
150	360		

c. Open the cover lid to the sensor assembly. Verify that the links J5 and J6 on Microprocessor-A PCBA is configured as sensor ID #1. (Both jumpers on pins 1 and 2.) Route the Wind Sensor Interconnection cable assembly through the sensor's bottom mounting support and attach the cable to the sensor terminal block as shown in FIGURE 5-19. Close and tighten sensor lid cover.

d. Open the wind tunnel test section door and remove both test section floor plates.

e. Connect the Wind Sensor Interconnection cable assembly to the connector of the cable assembly extending from top of the Sensor Mounting Stub.

f. Slip the top of sensor assembly into the wind tunnel test section through the opening in the test section floor. Then slip the bottom sensor support pipe onto the Sensor Mounting Stub. Ensure that the notch of the sensor support pipe is resting firmly around the pin protruding from the Sensor Mounting Stub. Tighten the sensor assembly U-bolt securely.

g. Secure both wind tunnel test section floor plates around the sensor assembly. Close the test section door.

h. Note the position of the sensor on the rotary turntable. Move sensor to nearest degree by turning adjustment knob on front of the rotary turntable.

i. Apply AC power to the sensor and turn the sensor circuit breaker CB1 to the ON position.

j. Turn the computer on or if already on, press the ALTERNATE, CONTROL, and DELETE keys simultaneously to make the computer re-boot. Once the computer has completed the boot procedure, type the command:

CALRUG

This command will tell the computer to change directories to the area of memory where the program and associated files reside and begin execution of the appropriate program. The user will be prompted to perform certain tasks and the computer will conduct a System Calibration Check. The program will then display the main menu as follows:

SUTRON WIND SENSOR TEST PROGRAM

1) COMPUTER CONTROLLED ..... TRUE, AC MOTOR

2) DATE 06-09-1987

3) SENSOR ID# .....

4) TYPE OF TEST ..... CALIBRATION TEST
rugged sensor

5) TABLE POSITION 0

6) FILE NAME .....

7) OPERATOR.....

RELATIVE HUMIDITY
44.7%

H FOR HELP TO SETUP HARDWARE
R TO RUN PROGRAM.....
Q TO QUIT
E TO EDIT FILE.DAT .....

BAROMETRIC PRESSURE
998.39 mB

TEMPERATURE
22.66 deg C

k. To enter the Sensor ID # which is the serial number for the control assembly the operator should enter "3" next to the question mark. At this time, the control assembly serial number should be entered as a 5 character code.

NOTE

The control assembly serial number is located on the mounting plate used to join the A-B microprocessor assembly and the anemometer. (See FIGURE 5-20.)

l. The operator should verify that the position of the test set turntable is at 0 degrees. If the rotary table is not at 0 degrees, enter "5" on the main menu to change the position of the rotary table. For example, if the table position is at 35 degrees, the following instructions will move the sensor to 0 degrees. After "5" has been entered, the following prompt will appear:

ENTER 1.....TO ROTATE TABLE A FRACTION OF A DEGREE
ENTER 2.....TO SET UP POSITION OF TABLE

The operator should enter "2" to correct the sensor position. The next prompt is:

ENTER SENSOR POSITION ?

The operator would respond the current sensor position or, for our example, the response would be "35". The next prompt tells the computer how far to rotate the table position.

ENTER DEGREES TO ROTATE TABLE

POSITIVE VALUE FOR COUNTERCLOCKWISE
NEGATIVE VALUE FOR CLOCKWISE

The operator would respond "-35" or "325" depending on which way the table should rotate. This option is given to prevent wrapping sensor wires around the sensor stand as the sensor rotates.

o. The operator should then enter "7" to change the seventh parameter. This will allow the operator to enter his or her name into the program.

5-15.6.4 **Test Procedures**.

a. The operator should enter "R" to run the test at this point. The program will begin execution at this point and the wind tunnel sensors data will be displayed as current information as shown below:

SUTRON WIND TUNNEL TEST PROGRAM

SENSOR POSITION .....0 TEMPERATURE .....22.36 C

ATMOSPHERIC PRESSURE = 1009.72 mB 757.35 mmHg.....29.82 Hg

DIFFERENTIAL PRESSURE .000 "H20 .000 "Benzene ..... .00 m Benzene

Wind Speed in Knots = 0

SPEED = 0 DIRECTION = 0

GAIN 1 reading : .06713867185
GAIN 2 reading : .06579589375
GAIN 10 reading : .0658691435

***** NOT WRITING TO FILE *****

** ENTER S .. TO BEGIN TEST or TO RETURN TO MENU **

b. The information will be refreshed every couple of seconds to reflect current readings. If the data displayed is valid, then the operator should enter "S" to gain control of the program. A prompt will appear:

ENTER Q -- TO QUIT or ENTER R -- TO RUN ?

Responding with "Q" will cause the program to return to the parameter input menu while responding with "R" will cause the program to continue execution.

c. The user will be prompted to enter the sensor serial number. This is the serial number found on the sensor chassis. If the test is being conducted as a subassembly test of the control assembly enter five spaces with double quotations (i.e. " ").

d. The user will be prompted to install the zero cap over the top of the sensor if the test set computer determines it is necessary.

e. After the test set takes the first test point, the user will be prompted to remove the zero cap from the sensor.

f. The test will now run to completion, displaying values on the computer screen, logging results to a file.

NOTE

If the test needs to be stopped for any reason, holding the CONTROL key down and entering "Q" (CONTROL-Q) will cause the parameter input menu to be displayed.

g. The user will be prompted to install the zero cap over the top of the sensor if the test set computer determines it is necessary.

h. After the test set takes the last test point, the user will be prompted to remove the zero cap from the sensor.

i. When the calibration test is completed, the user will be prompted to check that the printer is ON LINE and at the top of the page. Verify and hit return.

j. Remove the printer printout and attach it to the Data Test sheet. The PASS/FAIL test results will be printed at the bottom of the printout.

k. Turn the sensor circuit breaker CB1 off and remove the AC power from the sensor.

l. Remove the sensor from the Sensor Mounting Stub by reversing the procedures performed in 5-15.6.3.

m. Open the sensor cover lid and disconnect the Wind Sensor Interconnection cable from the wind sensor terminal block.

n. Ensure that the screws on terminal block are tight and will not work loose during transport. Close and tighten the sensor cover lid.

5-16 SENSOR REFURBISHMENT.

Sensor refurbishment refers to the process of characterizing a repaired Control Assembly. The Control Assembly contains several parts which have been characterized. This means that the output response or the electrical characteristic of the device has been measured and recorded. This recorded information has been stored in the Control Assembly EPROM (item # 17 of FIGURE 5-22) in the form of data tables. Table 5-40 lists the characterized parts of the control assembly and the A-B microprocessor assemblies. (Refer to FIGURES 5-20, 5-21, and 5-22.) If a characterized part is changed, the control assembly should be recharacterized per the following procedure.

Table 5-40. Characterized Parts

Item #	Name	P/N	Location	Ref.
	Anemometer	6661-1013	Control Assy	--
	A/D Converter	6661-1106	Micro-A PCBA	U5
	D/A Converter	6661-1107	Micro-A PCBA	U8
	D/A Converter	6661-1107	Micro-A PCBA	U9
	D/A Converter	6661-1107	Micro-B PCBA	U13
	D/A Converter	6661-1107	Micro-B PCBA	U14
	Resistor	6661-1105-1	Micro-A PCBA	R40
	Resistor	6661-1105-2	Micro-A PCBA	R39
	Resistor	6661-1105-3	Micro-A PCBA	R37
	Resistor	6661-1105-3	Micro-A PCBA	R38
	Resistor	6661-1105-4	Micro-A PCBA	R41
	Resistor Network	6661-1114	Micro-A PCBA	RN2
	Resistor Network	6661-1114	Micro-A PCBA	RN3
	Resistor Network	6661-1114	Micro-B PCBA	RN1
	Resistor Network	6661-1114	Micro-B PCBA	RN2
	Pressure Sensor	6661-1108	Micro-A PCBA	--

5-16.1 **Control Assembly Characterization.** This section provides the procedures used to characterize the direction and speed performance for the Control Assembly 6661-1013 of the Wind Direction and Speed Sensor ML660/FMQ-13 and ML660A/FMQ-13.

5-16.2 **Equipment Required But Not Supplied** The following is a list of equipment required to accomplish characterization of the control assembly.

a.Wind Sensor Characterization/Calibration test set, Sutron P/N 6700-1013.
b.Wind Sensor Characterization Program software disk, Sutron P/N 8202-1012.
c.Wind Sensor Interconnection cable assembly, Sutron P/N 6411-1081.
d.Zero Cap (Sensor Static Assembly), Sutron P/N 6661-1019 or equivalent.

5-16.3 **Standard Test Conditions.** Unless otherwise specified, perform all tests under these conditions:

a.Ambient Temperature: 25 ± 10°C
b.Ambient Humidity: 90% Maximum
c.Ambient Pressure: Local Atmospheric
d.Supply Voltage: 120 VAC ± 10%

5-16.4 **Preliminary.** Refer to FIGURE 5-18 for the following preliminary setup procedures.

NOTE

The control assembly is tested while installed in a sensor chassis. The references below to sensor or sensor assembly refers to the control assembly under test installed in a sensor chassis.

a.Verify that the AC power cord in the sensor is disconnected from the AC power source.

b.Verify that the sensor circuit breaker CB1 is in the OFF position.

c.Verify that the links J5 and J6 on the Microprocessor A PCBA is configured as sensor ID#1. (Both jumpers on pins 1 and 2).

d.Route the Wind Sensor Interconnection cable assembly through the sensor's mounting support and attach the cable to the sensor terminal block as shown in FIGURE 5-19. Close the tighten the sensor lid cover.

e.Open the wind tunnel test section door and remove both test section floor plates.

f.Connect the Wind Sensor Interconnection cable assembly to the connector of the cable assembly extending from top of the Sensor Mounting Stub.

g.Slip the top of sensor assembly into the wind tunnel test section through the opening in the test section floor. Then slip the bottom sensor support pipe onto the Sensor Mounting Stub. Ensure that the notch of the sensor support pipe is resting firmly around the pin protruding from the Sensor Mounting Stub. Tighten the sensor assembly U-bolt securely.

h.Secure both wind tunnel section floor plates around the sensor assembly. Close the test section door.

i.Note the position of the sensor on the rotary turntable. Move the sensor to nearest degree by turning adjustment knob on front of the rotary turntable.

j.Apply AC power to the sensor and turn the sensor circuit breaker CB1 to the ON position.

k.Make sure that the wind tunnel is shut down prior to running the program.

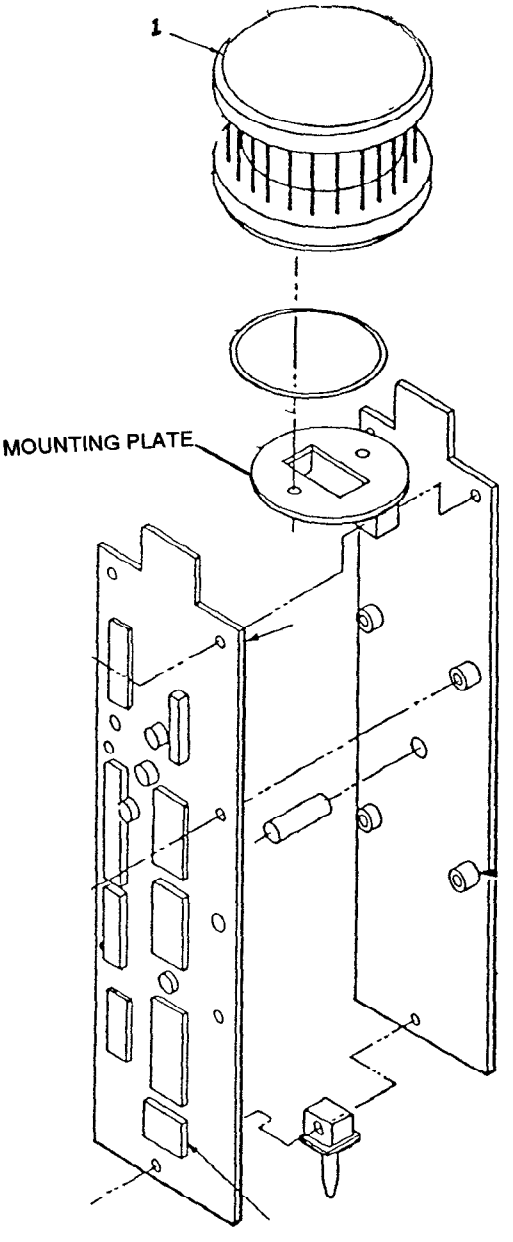


FIGURE 5-20. Sensor Control Assembly

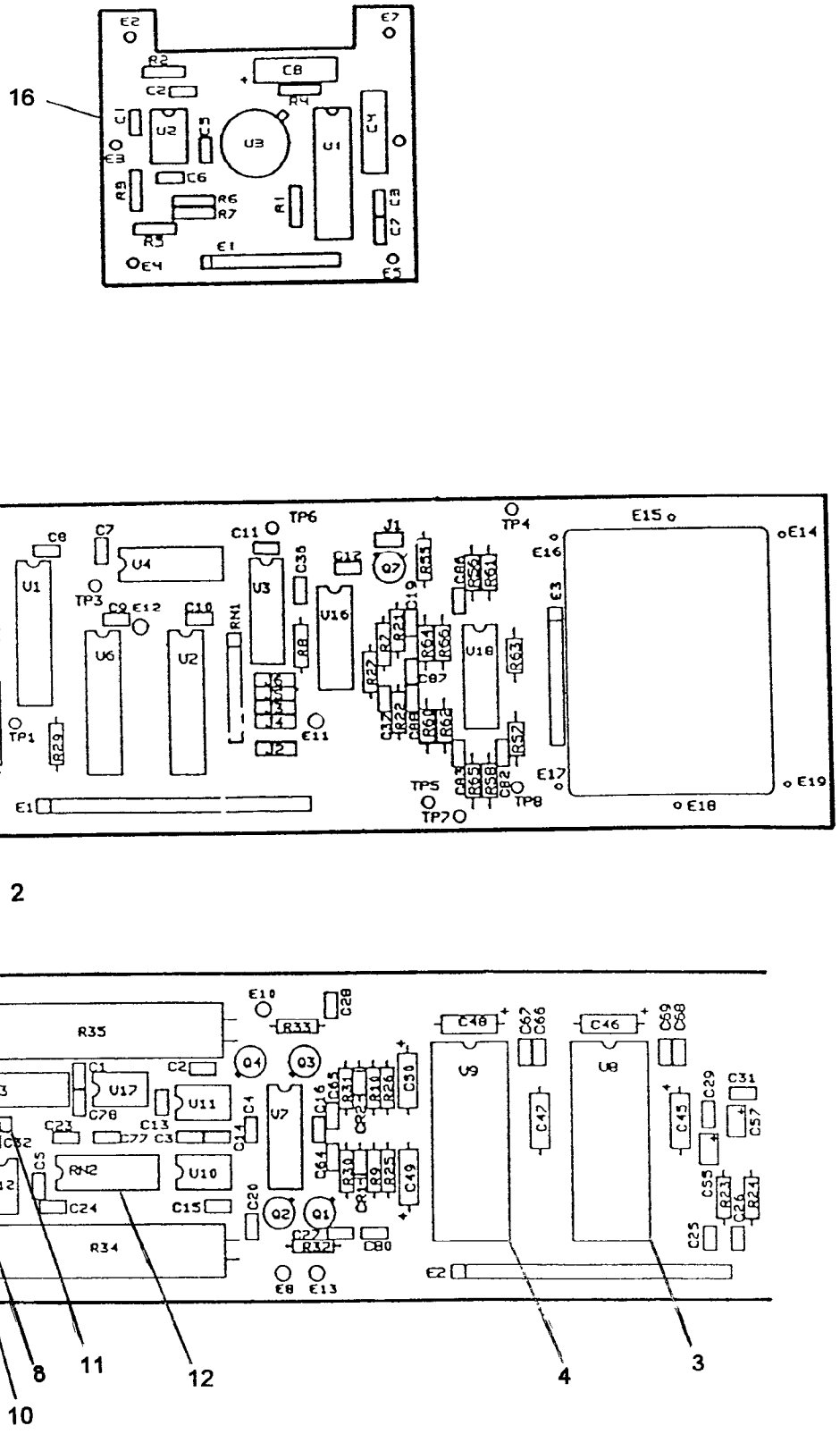


FIGURE 5-21. Microprocessor A Assembly

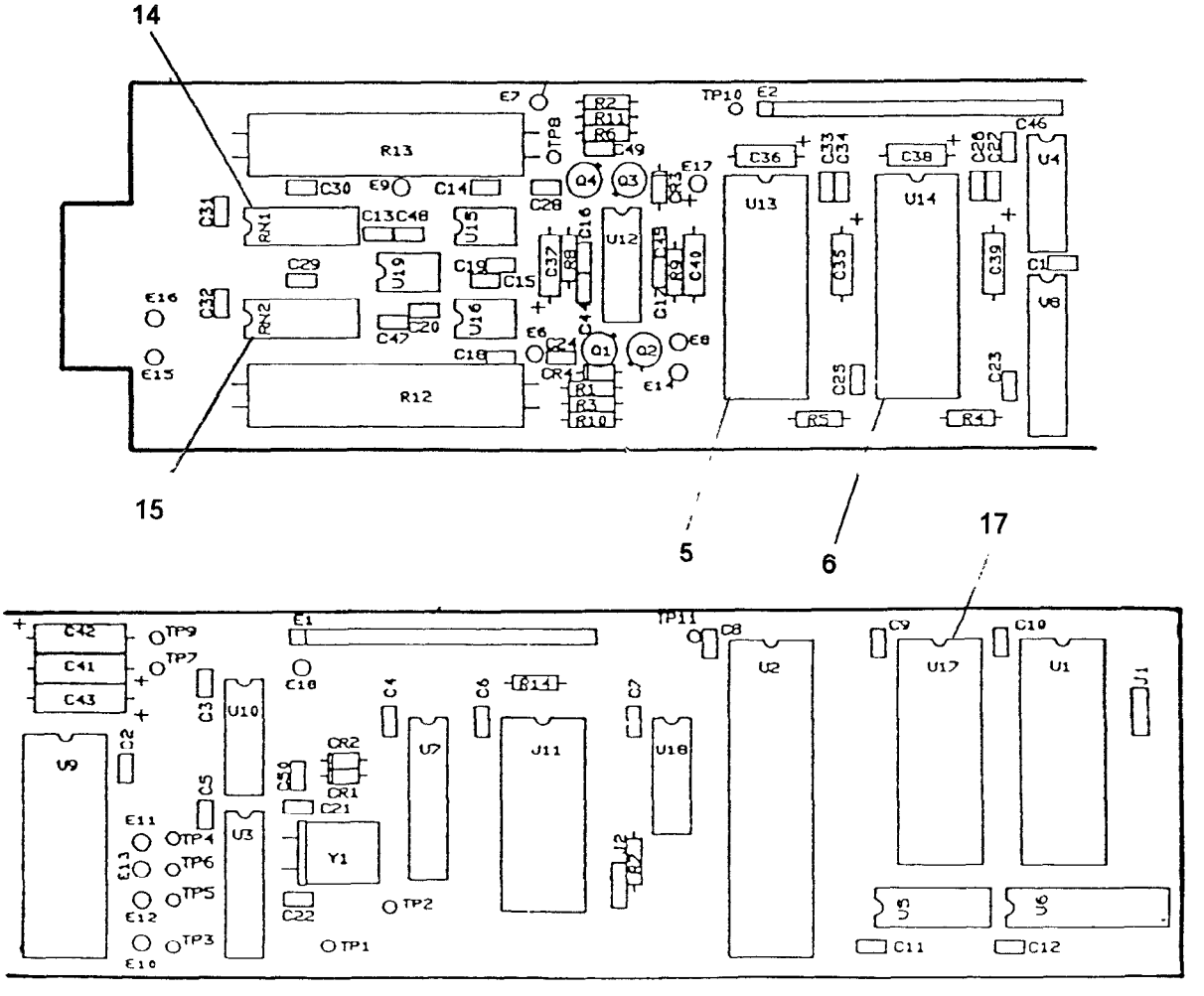


FIGURE 22. Microprocessor B Assembly

l.Make sure that the COMPUTER/MANUAL switch on the control panel is switched to COMPUTER.

m.Note the position of the sensor turntable before running.

n.Make sure the printer is ON LINE.

5-16.5 **Setup of Test Parameters.** Follow the steps below to set up the test parameters on the test set computer.

a.After turning on the computer or if it is already on, press the ALT, CTRL, and DEL keys simultaneously. Then at the 'C>' prompt type:

CHAR

This will load and run the characterization program.

b.The program takes approximately 15 seconds to initialize variables. The program will run a "SYSTEM CALIBRATION TEST". Make sure that all tests passed and press RETURN at the prompt. If any of the tests "FAILED", refer to T.O. (TBD) for troubleshooting procedures. The system calibration test screen is shown in FIGURE 5-23.

The first test is a zero test, which is done while the tunnel is still off.

c.The main menu will be displayed in FIGURE 5-24.

d.The operator should enter the control assembly serial number by pressing "3" and entering the Sensor ID# at the prompt.

NOTE

The control assembly serial number is located on the metal plate used to join the A-B microprocessor PCBA and the anemometer. (See FIGURE 5-20.)

e.The rotary table should be positioned at 0 degrees. To change the table position, the operator should type a "5". The program will prompt as follows:

ENTER 1 ..... TO ROTATE TABLE A FRACTION OF A DEGREE
ENTER 2 ..... TO SET UP POSITION OF TABLE

If the sensor is not 0 degrees, this option will be needed to reset the table. For example, if the table position is at 35 degrees, the following instructions will move the sensor to 0 degrees. The operator should enter "2" to correct the sensor position. The next prompt is:

ENTER SENSOR POSITION ?

The operator would respond the current sensor position or, for our example, the response would be "35". The next prompt tells the computer how far to rotate the table.

ENTER DEGREES TO ROTATE TABLE

POSITIVE VALUE FOR COUNTERCLOCKWISE
NEGATIVE VALUE FOR CLOCKWISE

SYSTEM CALIBRATION TEST

SCALE	D/A OUTPUT	A/D INPUT	PASS/FAIL
GAIN: 10	404	201.12	PASS
GAIN: 2	2020	1009.45	PASS
GAIN: 1	4040	2019.80	PASS
GAIN: 10	4	1.29	PASS
GAIN: 2	4	1.95	PASS
GAIN: 1	4	1.80	PASS

FIGURE 5-23. System Calibration Test

The operator would respond "-35" or "325" depending on which way the table should rotate. This option is given to prevent wrapping sensor wires around the sensor stand as the sensor rotates.

f. The operator should then enter "7" and input his or her name at the prompt.

5-16.6 **Test Procedures.**

a. The operator should enter "R" to run the test. The program will begin collecting data. The test screen will appear and will be refreshed with data at approximately 5 second intervals. The test screen displays the information as shown in FIGURE 5-25.

b. If all the data being displayed is valid, press an "S" to begin the test. After the screen has refreshed, the operator should see on the bottom of the screen a prompt:

ENTER Q -- TO QUIT or ENTER R -- TO RUN

Responding with "Q" will cause the program to return to the main menu while responding with "R" will cause the test to begin execution. If the test needs to be stopped for any reason, holding the CONTROL key, "CTRL", while pressing "Q" will return to the main menu.

NOTE

If the message "REPOLLING" appears along with a beep, instead of the test screen, this indicates that the program is not receiving data from the sensor. Call supervisor if this message appears.

c. Since the first test run on the sensor is a zero wind test, the user will be instructed when to install the zero cap on the sensor.

d. At the end of the test, the operator will be prompted to remove the zero cap.

e. The operator will be prompted to turn on the wind tunnel and hitting the return key after the tunnel has been turned on. The test will now run to completion, displaying values on the computer screen, and writing the data to an output file. (Test duration is approximately 8 hrs.)

f. After the tests are completed, the program returns to the main menu. The operator should type a "Q" which will return them to DOS. The 'C>" prompt will appear.

g. Turn off the wind tunnel.

h. Turn the sensor circuit breaker CB1 off and remove the AC power from the sensor.

i. Remove the sensor mounting stub by reversing the procedures performed in 5-16.3.1.

j. Open the sensor cover lid and disconnect the Wind Sensor Interconnection cable from the wind sensor terminal block.

k. Ensure that the screws on terminal block are tight and will not work loose during transport. Close and tighten the sensor cover lid.

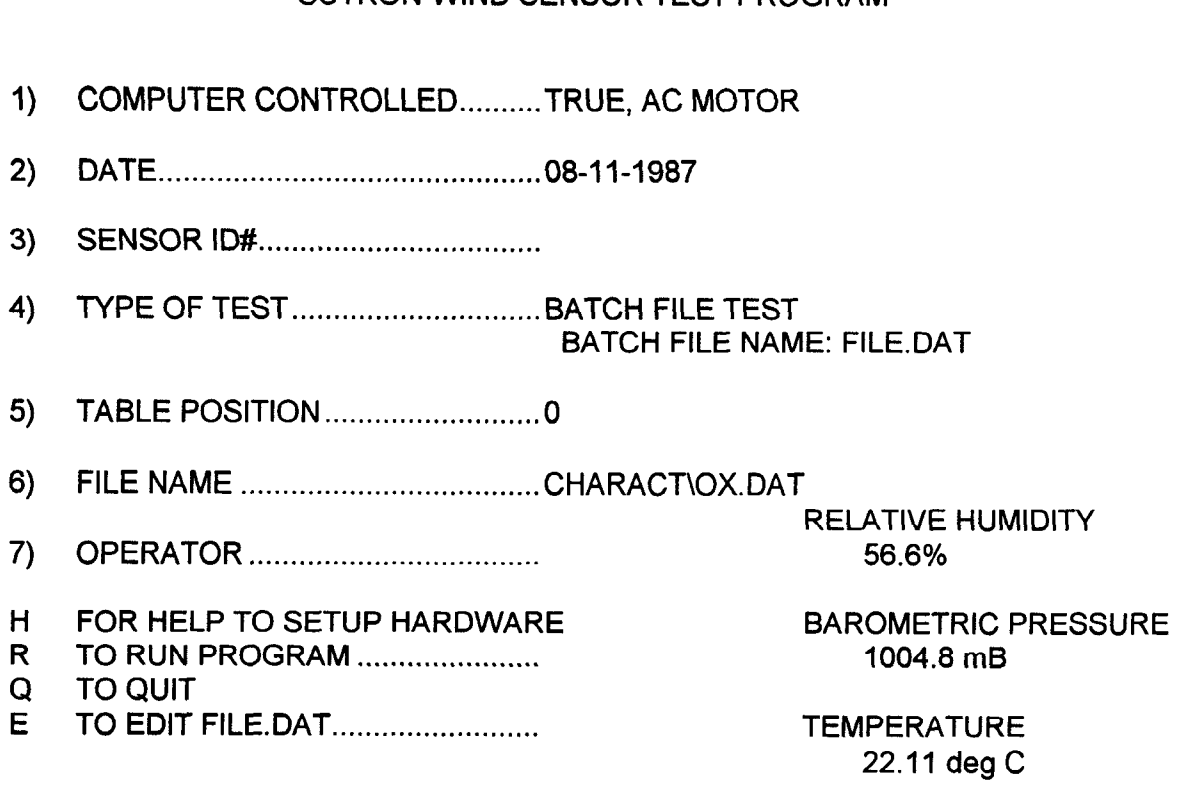


FIGURE 5-24. Main Menu Screen - Characterization Setup

SUTRON WIND TUNNEL TEST PROGRAM

SENSOR POSITION = 0 TEMPERATURE = 18.10 C

ATMOSPHERIC PRESSURE = 1004.55 mB 753.48 mmHg 29.66 Hg

DIFFERENTIAL PRESSURE 0.002 H20 0.002 Benzene 0.050 mm Benzene

Wind Speed in Knots = 0.00

SENSOR DATA .....
2534 2386 2389 2365 2312 29375 10092 3422 3422 3463 3374 767 680 672 677

GAIN 1 reading : 0.02539
GAIN 2 reading : 0.02393
GAIN 10 reading : 0.02456

***** NOT WRITING TO FILE *****

** ENTER S .. TO BEGIN TEST or TO RETURN TO MENU **

FIGURE 5-25. Characterization Run-Time Screen

ALPHABETICAL INDEX

ALPHABETICAL INDEX - CONT

ALPHABETICAL INDEX - CONT

ALPHABETICAL INDEX - CONT

CROSS-REFERENCE INDEX

CROSS-REFERENCE INDEX - CONT

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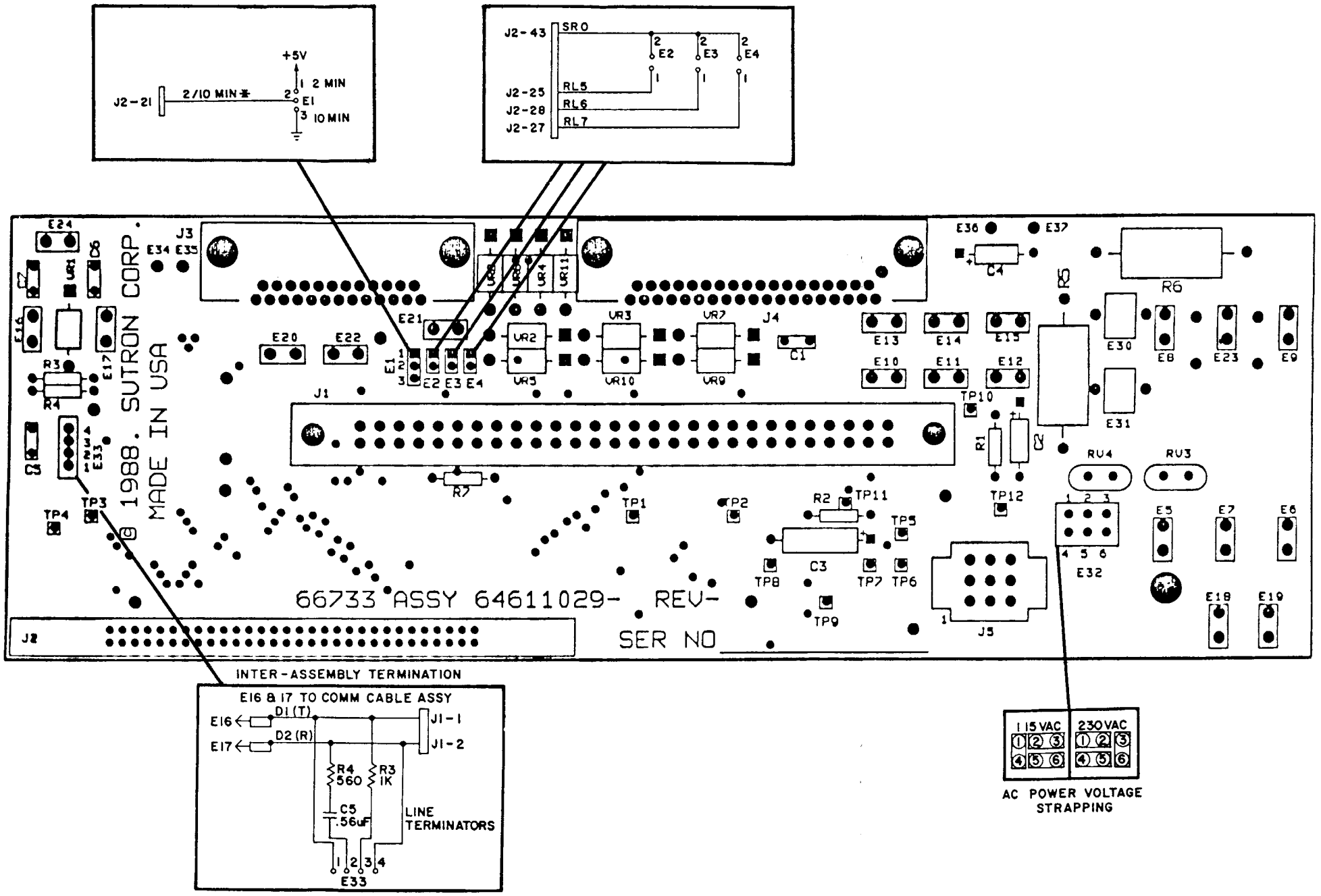
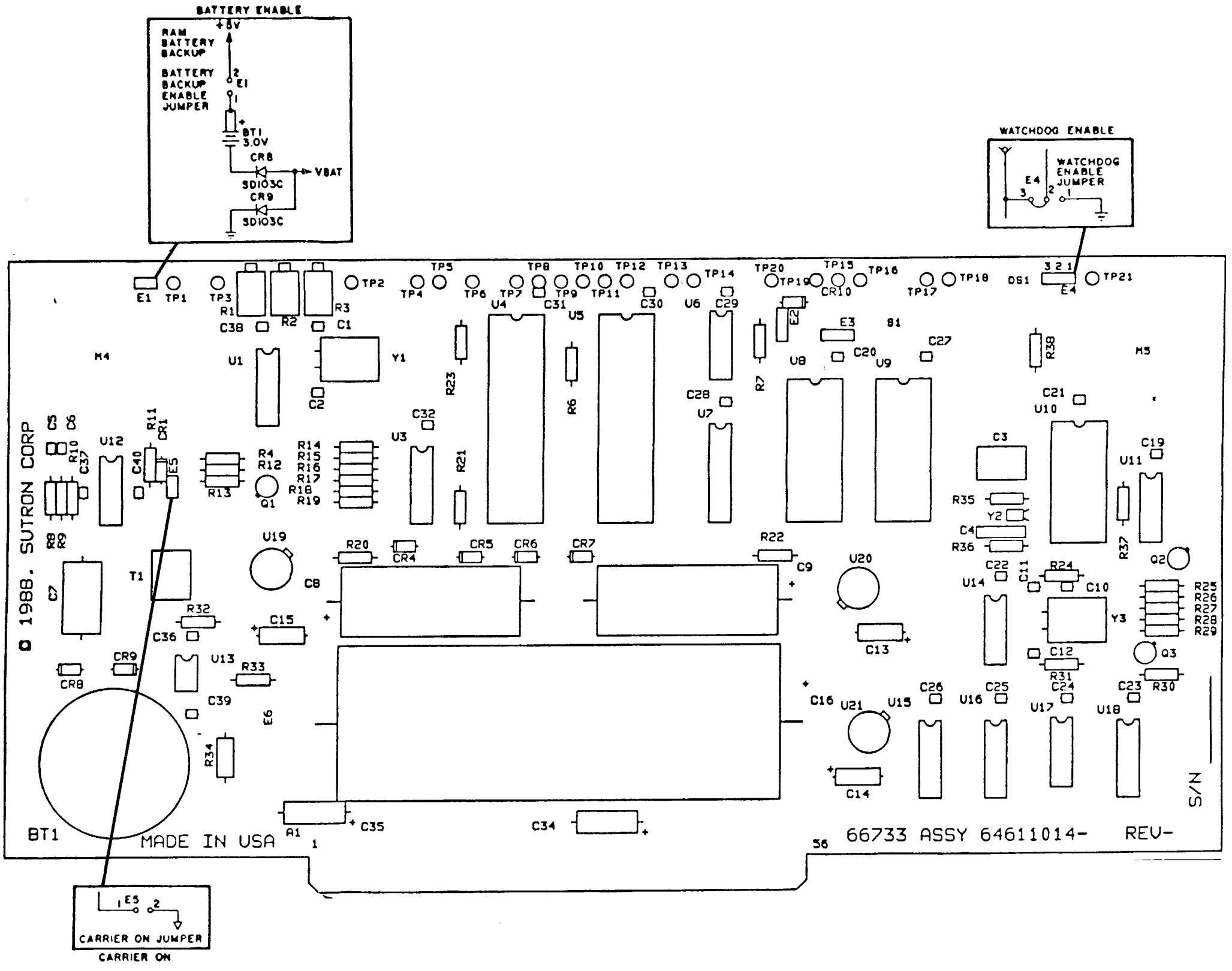
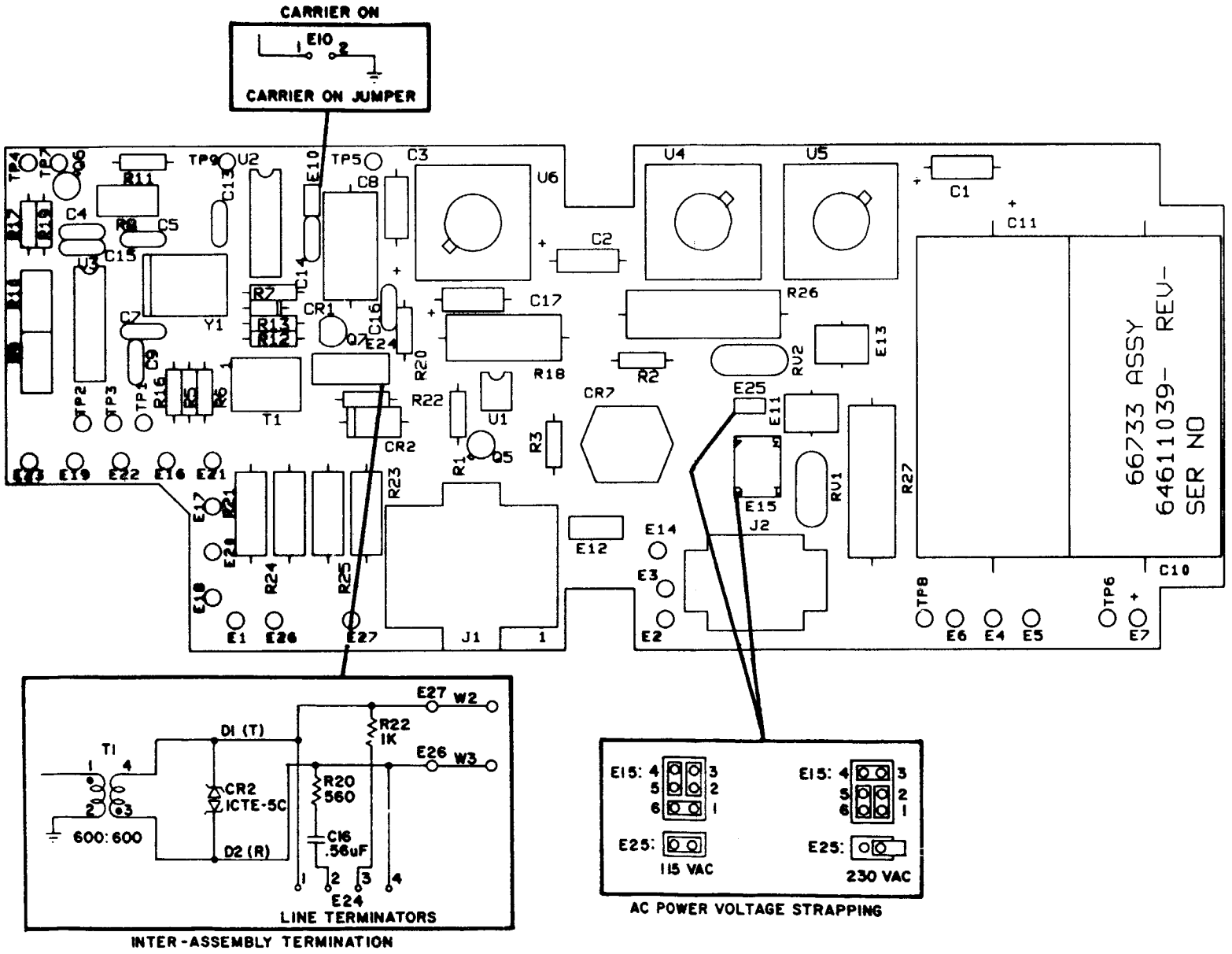


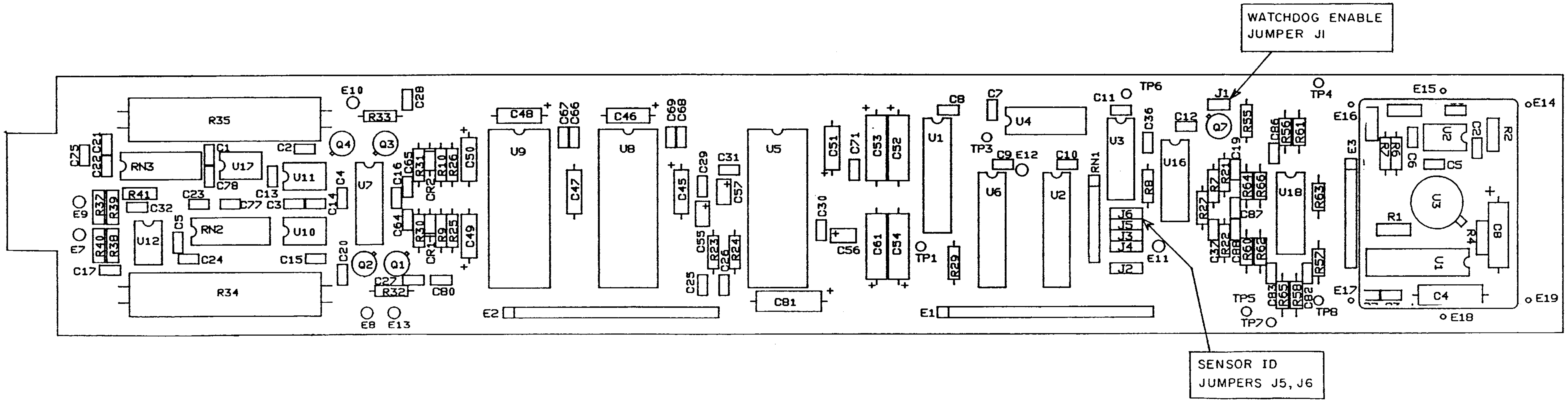
FO-1. Indicator/Recorder Interconnect PCBA - Location of Jumper



FO-2. Indicator/Recorder Microprocessor PCBA - Location of Jumpers



FO-3. Sensor Power Front - Location of Jumpers



FO-4. Sensor Microprocessor A PCBA -
Location of Jumpers